Report of Subsurface Exploration and Geotechnical Evaluation
Muscogee Creek Nation (MCN) - Meat Processing Facility
Okmulgee, Oklahoma
Building & Earth Project No.: OK200205

Prepared For:
Thompson Construction, Inc.

September 21, 2020

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Ave
Tulsa, OK 74112
Ph: (918) 439-9005
www.BuildingAndEarth.com

September 21, 2020

Thompson Construction, Inc.
8141 E 74th Place
Tulsa, Oklahoma 74133

Attention: Mr. Kendall Carter

Subject: Report of Subsurface Exploration and Geotechnical Evaluation
Muscogee Creek Nation (MCN) - Meat Processing Facility
Okmulgee, Oklahoma
Building & Earth Project No: OK200205

Dear Mr. Carter:

Building & Earth Sciences, Inc. has completed the authorized subsurface exploration and geotechnical engineering evaluation for the MCN Meat Processing Facility located in Okmulgee, Oklahoma.

The purpose of this exploration and evaluation was to determine general subsurface conditions at the site and to address applicable geotechnical aspects of the proposed construction and site development. The recommendations in this report are based on a physical reconnaissance of the site and observation and classification of samples obtained from eleven (11) test borings conducted at the site. Confirmation of the anticipated subsurface conditions during construction is an essential part of geotechnical services.

We appreciate the opportunity to provide consultation services for the proposed project. If you have any questions regarding the information in this report or need any additional information, please call us.

Respectfully Submitted,
BUILDING & EARTH SCIENCES, INC.
Certificate of Authorization, #3975, Expires 6/30/2022

Dharmateja Maganti, E.I.
Project Manager

Marco V. Vicente Silvestre, P.G., P.E.
Regional Vice President
OK: 21903

Table of Contents

APPENDIX

EXECUTIVE SUMMARY

The subsurface exploration and geotechnical engineering evaluation, which is the subject of this report, has been implemented to define the general conditions, which should be considered in the design and site preparation specifications for the project. The following is a summary of our recommendations and considerations to aid with design and construction of the proposed development. Refer to subsequent sections within the report for a detailed discussion of these topics.

- Site development considerations:
    - Initial site preparation should consist of the removal of removal of existing trees, tree stumps, root systems, desiccated soils, grass, and topsoil.
    - Onsite clay soils in the proposed Meat Processing Facility will require undercutting and replacement to reduce the maximum Potential Vertical Rise (PVR) to levels that are tolerable for planned slabs-on-grade. The building areas extending at least 5 feet beyond the building perimeter lines are to be undercut as follows, depending on specified maximum PVR for this project:

Design Maximum PVR (inches)	Recommended Minimum Lower Plasticity Structural Fill Below Grade Supported Slabs (feet)
~ 1	3.0
~ ¾	4.0
~ ½	5.5

    - The subgrade in building and pavement areas is to be scarified to a depth of 8 inches, moisture conditioned to within a range of -1 to +3 percent of the optimum moisture content, and recompacted to at least 95 percent of the material's standard Proctor maximum dry density.
    - Onsite alluvial deposits encountered in the proposed lagoon areas, comprised of sandy lean clays (CL), appear suitable for use as lower plasticity structural fill in proposed building and pavement areas. Supplemental laboratory testing on bulk samples is recommended to further evaluate their suitability for their intended use.

- Onsite residual fat clays (CH) encountered in the Meat Processing Facility area appear suitable for use for lagoon liner construction. Supplemental laboratory testing on remolded test specimens is recommended to further evaluate their suitability for their intended use.

- Groundwater was encountered at depths of 7 to 10 feet in the lagoon areas. Weathered shale and sandstone with thickness of about 1.5 to 2 feet were encountered below alluvial clay soils at depths of about 9 to 14 feet. The alluvium and weathered rock were underlain by hard limestone and soft to moderately hard shale at depths of about 8.5 to 15.5 feet. Auger refusal occurred on limestone at depths ranging from 9 to 22.5 feet. Design and construction of lagoons are to take these subsurface conditions into consideration.

- Foundation considerations:

  - The proposed building can be supported on conventional shallow footings bearing in new structural fill or stiff residual clays that are dimensioned using a maximum net allowable bearing capacity of 2,500 psf.

  - The residual clays exhibited higher plasticity characteristics; as such, the contractor should use caution during foundation construction as to not allow the bearing soils to dry while exposed to the elements. Desiccated soils will need to be undercut prior to placement of reinforcing steel and replaced with properly compacted, approved lower plasticity structural fill.

- Pavement considerations:

  - Pavement sections should be supported on either lime stabilized subgrade with a thickness of 8 inches, or a low plasticity structural fill subbase with a thickness of 12 inches.

  - Consideration should be given to using rigid pavement sections for heavy duty drives, parking, and loading areas subjected to frequent heavy tractor-trailer truck traffic. Dowelled joints should be used for heavy duty drives subjected to daily heavy truck traffic.

1.0 PROJECT & SITE DESCRIPTION

The subject site is located approximately 1,500 feet south of the intersection of E0830 Road and Highway 75, near Okmulgee, Oklahoma. General information relative to the proposed site and the proposed development is listed in Table 1 below. Photographs depicting the current site conditions are presented on the following pages.

Development Item	Detail	Description
General Site	Size (Ac.) [3]	~ 5
	Existing Development	A smoke shop with asphalt pavement around the building was noted to the west of the proposed meat processing facility. Three (3) larger barns were noted to the south and east of the proposed facility.
	Vegetation	Project area was covered in tall grass at the time of site reconnaissance. A small creek was noted to northwest of the proposed lagoon area, and a pond was noted east of the proposed facility location. Mature trees were noted near the existing creek
	Slopes	Proposed facility and lagoon areas are relatively flat with slight slopes towards the existing creek
Proposed Buildings	No. of Bldgs.	One (1)
	Square Ft.	Roughly 26,000 square feet
	Stories	Single Story (assumed)
	Construction	Concrete, tilt-up panels
	Column Loads [1]	50 kips (provided)
	Wall Loads [1]	2 to 4 kips per linear foot (provided)
	Preferred Foundation	Conventional Shallow Foundation (assumed)
	Preferred Slab	Slab-on-Grade (assumed)
Pavements	Traffic	Not Provided, assumed ESAL capacities
	Standard Duty	160,000 (assumed)
	Heavy Duty	550,000 (assumed)
Additional Proposed Construction	Lift Station and Lagoons	Lift Station: Northeast of planned meat processing facility Proposed Lagoons: Southeast of existing creek crossing

Table 1: Project and Site Description

Reference:

- Scope of Work for Geotechnical Investigation, prepared by New Fire Native Design Group
- Site Plan, prepared by Search, LLC, dated 8/5/20
- Site Sketch, unnamed and undated

Table 1 Notes:

1. ***If final loading conditions exceed preliminary given loads, Building & Earth Sciences should be allowed to review the proposed structural design and its effects on our recommendations for foundation design.***
2. ***It should be noted that at the time of preparing this report, information regarding building footprint, layout, and grading was not available. Since information on layout and final grades was not provided, assumptions have been made for the purpose of this report. Therefore, it will be essential for Building & Earth to review the site plan and topographic and proposed grading plans, when they become available, and be contracted to provide supplemental recommendations when warranted based on the new project information.***
3. ***We understand the proposed construction includes multiple lagoons to the southeast of the proposed facility. As part of our scope of work for this project, we have collected subsurface information in the general vicinity of the proposed lagoon locations. This data can be found in the Appendix of this report.***

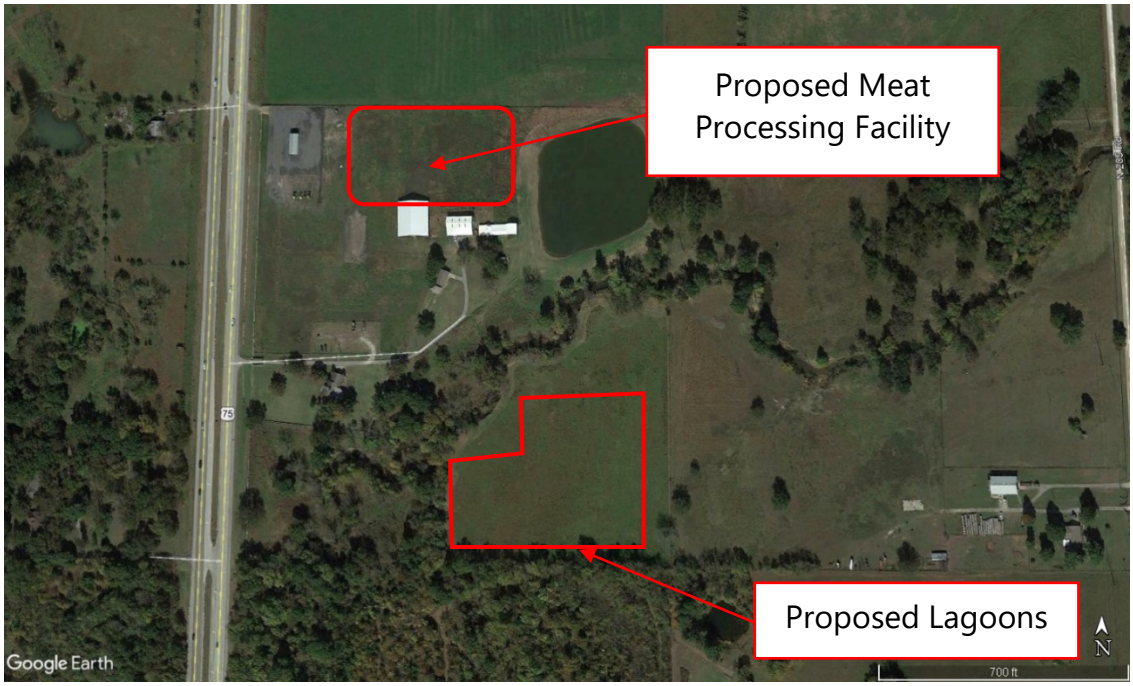


Figure 1: Approximate Location of the Project Site, (Google Earth October 2018)

At the time of our site reconnaissance, the planned construction area was covered with grass and topsoil. An existing creek was noted to the northwest of the proposed lagoons, and a pond was noted to the east of the proposed facility location.

Figure 2: Photo taken east of boring B-01, looking east. Note the pond mentioned in Table 1

Figure 3: Existing creek located to the northwest of the proposed lagoon area

Figure 4: Photo taken north of boring B-06 looking southeast

Figure 5: Proposed Meat Processing Facility Area, looking southeast

2.0 SCOPE OF SERVICES

The authorized subsurface exploration was performed on Wednesday, September 2, 2020 and Friday, September 4, 2020 in conformance with our proposal OK22341, dated August 28, 2020. Notice to proceed was provided by Thompson Construction, Inc., by signing and returning our proposal the same day.

The purpose of the geotechnical exploration was to determine general subsurface conditions at specific boring locations and to gather data on which to base a geotechnical evaluation with respect to the proposed construction. The subsurface exploration for this project consisted of eleven (11) test borings. The site was drilled using a Diedrich D50 ATV drill rig equipped with hollow stem augers and an automatic hammer.

The boring locations were determined in the field by a representative of our staff using a handheld GPS device. As such, the boring locations shown on the Boring Location Plan attached to this report should be considered approximate.

The soil/rock samples recovered during our site investigation were visually classified and specific samples were selected by the project engineer for laboratory analysis. The laboratory analysis consisted of:

Test	ASTM	No. of Tests
Natural Moisture Content	D2216	42
Atterberg Limits	D4318	8
Material Finer Than No. 200 Sieve by Washing	D1140	3
Unconfined Compression Test on Soil Samples	D2166	2
Water Soluble Chloride and Sulfate, and pH	N/A	2

Table 2: Scope of Laboratory Tests

The results of the laboratory analysis are presented on the enclosed Boring Logs and in tabular form in the Appendix of this report. Descriptions of the laboratory tests that were performed are also included in the Appendix.

The information gathered from the exploration was evaluated to determine a suitable foundation type for the proposed structure. The information was also evaluated to help determine if any special subgrade preparation procedures will be required during the earthwork phase of the project.

The results of the work are presented within this report that addresses:

- General site geology.
- Summary of existing surface conditions.
- A description of the subsurface conditions encountered at the boring locations.
- A description of the groundwater conditions observed in the boreholes during drilling.
    - A monitoring well was installed at boring location B-07, and borings B-08 through B-11 were left open for delayed groundwater readings.
- Presentation of laboratory test results.
- Site preparation considerations including material types to be expected at the site, treatment of any encountered unsuitable soils, excavation considerations, and surface drainage.
- Recommendations to be used for design of loading dock walls, including lateral earth pressures, coefficient of friction, and subsurface drainage provisions.
- General corrosivity potential assessment.
- Recommendations to be used for design of slabs-on-grade, including modulus of subgrade reaction.
- Seismic Site Classification per IBC 2015 based on SPT test boring information.
- Compaction requirements and recommended criteria to establish suitable material for structural backfill.
- Recommended typical flexible and rigid pavement sections based on assumed traffic loading conditions.

3.0 GEOTECHNICAL SITE CHARACTERIZATION

The following discussion is intended to create a general understanding of the site from a geotechnical engineering perspective. It is not intended to be a discussion of every potential geotechnical issue that may arise, nor to provide every possible interpretation of the conditions identified. The following conditions and subsequent recommendations assume that significant changes in subsurface conditions do not occur between boreholes. However, anomalous conditions can occur due to variations in existing fill that may be present at the site, or the geologic conditions at the site, and it will be necessary to evaluate the assumed conditions during site grading and foundation installation.

3.1 GEOLOGY

3.1.1 PROPOSED MEAT PROCESSING FACILITY

Based upon review of the United States Geological Survey (USGS) open file report 03-247, *A Digital Geologic Map Database of Oklahoma*, the subject site north of the existing creek is underlain by the Wewoka Formation. The formation is composed of shale, sandstone, and minor limestone in various combinations, and generally yields only limited amounts of poor-quality water.

3.1.2 PROPOSED LAGOON AREA

Based upon review of the United States Geological Survey (USGS) open file report 03-247, *A Digital Geologic Map Database of Oklahoma,* the project site south of existing creek is underlain by Alluvial Deposits primarily comprised of sandy clays, clayey sands, and silty sands. The alluvial deposits were underlain by the Wewoka Formation.

The subsurface conditions encountered at the project site generally correlate with the published geologic references.

3.2 EXISTING SURFACE CONDITIONS

At the time of our subsurface exploration on September 2, 2020 and September 4, 2020, the proposed project areas were on vacant land. The boring locations were covered in tall grasses and weeds. Mature trees and a small creek were noted to the northwest of the proposed lagoon area. A smoke shop surrounded by asphalt pavement was noted to the west of the proposed facility, and three (3) larger barns were noted to the south and east of the proposed facility.

Topsoil was encountered in the exploratory borings with an approximate thickness of 3 inches. The topsoil conditions reported apply only to the specific boring locations. For this report, topsoil is defined as the soil horizon which contains the root mat of the noted vegetation.

3.3 SUBSURFACE CONDITIONS

A generalized stratification summary has been prepared using data from the test borings and is presented in the table below. The stratification depicts the general soil/rock conditions and strata types encountered during our field investigation.

Stratum No.	Typical Thickness	Description	Consistency/Rock Hardness	Lab Testing Data [4]
1	1.7' to 4.7'	**Near Surface Residuum:** lean clays (CL) with fine roots, trace ferrous nodules and some sandstone fragments Dark brown, reddish brown, and grayish brown in color	Medium stiff to very stiff	*Atterberg Limits: LL = 35 and 39, PL = 16 and 14, PI = 19 and 25* *General Moisture Content Range: 13 to 23%*
2 [1]	2.5' to 7.5'	**Residual soils:** lean-to fat clays (CL-CH) and fat clays (CH) with ferrous staining and trace sandstone fragments Dark brown, brown, gray, yellowish brown, bluish gray, olive gray, olive, light yellowish brown, and dark grayish brown in color	Stiff to very stiff	*Atterberg Limits: LL = 45 to 50, PL = 15 and 16, PI = 33 to 35* *General Moisture Content Range: 17 to 28%*
3 [2]	3' to 7'	**Weathered Rock** consisting of clayey shale and weathered shale Light brown, brown, yellowish brown, light gray, olive brown, and light yellowish brown in color	Soft rock formation	*General Moisture Content Range: 14 to 17%*
4 [3]	Termination Layer	**Wewoka Formation** Shale, fissile Gray and light gray in color	Soft to moderately hard	*No tests performed*

Table 3: Stratification Summary – Proposed Meat Processing Facility Area

Table 3 Notes:

1. Borings B-05 and B-06 were terminated within the residual clay stratum at a depth of about 10 feet.
2. Borings B-02 and B-04 were terminated within the weathered rock stratum at a depth of about 15 feet.
3. Borings B-01, B-03, and B-07 were terminated within the Wewoka Formation at depths of about 19 to 24 feet.
4. For Atterberg Limits: LL = Liquid Limit, PL = Plastic Limit, and PI = Plasticity Index

Stratum No.	Typical Thickness	Description	Consistency/Rock Hardness	Lab Testing Data
1	2.2′ to 13.7′	**Alluvium:** lean clays and sandy lean clays (CL), and some sandy silty clays (CL-ML) with roots, black ferrous staining and silty sand seams and lenses Dark brown, reddish brown, light brown, grayish brown, light gray, yellowish red, yellowish brown, and reddish yellow in color	Medium stiff to stiff Soft to medium stiff soils were encountered in borings B-08 and B-09 at a depth of about 8.5 feet.	*Atterberg Limits:* *LL = 21 to 25,* *PL = 12 to 14,* *PI = 7 to 13* *General Moisture Content Range: 11 to 21%* *Percent Fines: 53 and 56%*
2 (1)	1.5 to 2′	**Weathered Rock** consisting of calcareous weathered shale and weathered sandstone with limestone seams Yellowish brown, brown, light gray, and dark gray in color	Sandstone: Poorly cemented Shale: soft	*No tests performed*
3 (2)	Termination Layer	**Wewoka Formation** consisting of shale and limestone Gray, dark gray, and light gray in color	Shale: Soft to moderately hard Limestone: hard	*No tests performed*

Table 4: Stratification Summary – Proposed Lagoon Area(s)

Table 4 Notes:

1. Encountered in borings B-09 and B-11 only.
2. Auger refusal was encountered in limestone at depths of about 9 to 22.5 feet in borings B-08 through B-11.

Subsurface profiles have been prepared based on the data obtained at the specific boring locations and is presented in the Appendix. For specific details on the information obtained from individual test borings, please refer to the Boring Logs included in the Appendix. The ground surface elevations at the boring locations indicated in this report were estimated from the elevation profile of the terrain feature on Google Earth.

3.3.1 AUGER REFUSAL

Auger refusal is the drilling depth at which the borehole can no longer be advanced using soil drilling procedures. Auger refusal can occur on boulders, buried debris or bedrock. Coring is required to sample the material below auger refusal. Auger refusal was encountered in borings B-08 through B-11 at the approximate depths listed in the table below.

Boring No.	Depth (ft)
B-08	15
B-09	15.5
B-10	9
B-11	22.5

Table 5: Auger Refusal Depths

3.3.2 GROUNDWATER

Proposed Meat Processing Facility Borings:

Groundwater was not encountered in borings B-01 through B-06 at the time of drilling or prior to backfilling during our subsurface exploration. Borings B-01 through B-06 were backfilled the same day that they were drilled.

Proposed Lift Station and Lagoon Borings:

Groundwater seepage was encountered during drilling at depths of about 8.5, 7, and 10 feet below existing grades, in lagoon borings B-08, B-09, and B-11, respectively.

As previously mentioned, a monitoring well was installed at lift station/meat processing plan boring location B-07, and lagoon borings B-08 through B-11 were left open for delayed groundwater readings. The following table summarizes groundwater depths referenced from the existing ground surface for borings B-07 through B-11.

Boring No.	Groundwater Depth During Drilling (ft)	Delayed groundwater reading, seven days after completion of drilling (ft)
B-07 (lift station)	Not encountered	4.2 (1)
B-08 (west lagoon)	8.5	Not determined due to cave-in
B-09 (west lagoon)	7	Not determined due to cave-in
B-10 (east lagoon)	Not encountered	Not determined due to cave-in
B-11 (east lagoon)	10	6.8

Table 6: Groundwater Depth

Table 6 Notes:

1. In accordance with the scope of work described in our proposal, a second water level reading will be recorded for the monitoring well installed at boring location B-07 on 9/2/2020. Thompson Construction will notify our office of next date for a water level reading event.

3.4 SEISMIC SITE CLASSIFICATION

Basis of Evaluation	Recommended Site Classification
2015 International Building Code (IBC) and ASCE 7, Chapter 20	C
This recommended seismic site classification is based on the 2015 Edition of the International Building Code, the subsurface conditions encountered in the borings, and our knowledge of the geologic conditions of the site. Our subsurface exploration extended to a maximum depth of about 25 feet; hence the seismic site classification should be re-evaluated in the event subsurface information is made available to a depth of 100 feet.	

Table 7: Seismic Site Classification

4.0 SITE DEVELOPMENT CONSIDERATIONS

A grading plan was not available at the time of this report. Based on the observed site topography, we assume limited cut and fill (less than 2 feet) will be required to achieve design grades within the proposed building and pavement areas.

When a grading plan is finalized, Building & Earth should be contracted to review the plan and its effects on our recommendations.

Based on our evaluation of the subsurface conditions, and the given preliminary foundation loads, it appears that construction with a shallow foundation system is feasible. The site development recommendations outlined below are intended for development of the site to support construction with a shallow foundation system. ***If a different type of foundation system is preferred, Building & Earth should be allowed to review the site development recommendations to verify that they are appropriate for the preferred foundation system.***

The primary geotechnical concerns for the proposed meat processing facility site are:

- The near-surface lean clay soils encountered across the proposed meat processing facility area are moisture sensitive and prone to losing strength and stability with slight increases in soil moisture contents and when subjected to repeat traffic loads.
- Residual clays encountered below near-surface lean clays in the meat processing facility area typically exhibited medium to high plasticity characteristics with a moderate to high shrink-swell potential.

- There is a high probability for development of perched water at the interface of near-surface, lean clays, and the underlying higher plasticity clays.
- Clayey shale and weathered shale units were encountered in borings B-01 through B-06 below the residual clays at depth of about 8.5 to 12 feet. Shale associated with the Wewoka Formation was encountered below the weathered stratum at depths of about 14 to 17 feet below current grades.

The primary geotechnical concerns for the proposed lagoon sites are:

- Alluvium comprised of lower plasticity lean clays, sandy lean clays, and sandy silty clays were encountered to depths of about 8.5 to 14 feet.
- The alluvium was underlain by rock units associated with the Wewoka Formation, which generally included weathered shale and sandstone with thickness of about 1.5 to 2 feet, underlain by hard limestone and soft to moderately hard fissile shale units. Auger refusal occurred in limestone at depths ranging from 9 to 22.5 feet.
- Groundwater was encountered in the alluvium and within the weathered rock units at depths of about 7 to 10 feet.

Recommendations addressing the site conditions are presented in the following sections.

4.1 Initial Site Preparation

All vegetation, roots, trees, topsoil, and any other deleterious materials, should be removed from the proposed construction areas. Approximately 3 inches of topsoil was observed in the borings; however, topsoil could extend to greater depths in unexplored areas of the site. For this report, topsoil is defined as the horizon which contains most of the root mat of the noted vegetation.

Grubbing of trees should include removal of the tree stumps and the root systems. Desiccated clay soils may be present in the zone surrounding the trees. Desiccated clay soils should be undercut and replaced with structural fill.

A geotechnical engineer should observe stripping and grubbing operations to evaluate that all unsuitable materials are removed from locations for proposed construction. Materials disturbed during clearing operations should be stabilized in place or, if necessary, undercut to undisturbed materials and backfilled with properly compacted, approved structural fill.

During site preparation activities, the contractor should identify borrow source materials that will be used as structural fill and provide samples to the testing laboratory so that conformance to the *Structural Fill* requirements outlined below and appropriate moisture-density relationship curves can be determined.

4.2 Moisture Sensitive Soils

Near-surface, lean clays were encountered across the site during the subsurface exploration. These soils are moisture sensitive and will degrade when allowed to become saturated. Therefore, not allowing water to pond by maintaining positive drainage and temporary dewatering methods (if required) is important to help avoid degradation and softening of the soils.

The contractor should anticipate some difficulty during the earthwork phase of this project if moisture levels are moderate to high during construction. Increased moisture levels will soften the subgrade and the soils may become unstable under the influence of construction traffic. Accordingly, construction during wet weather conditions should be avoided, as this could result in soft and unstable soil conditions that would require ground modification, such as in place stabilization or undercutting.

4.3 Building Pad Preparation – Proposed Meat Processing Facility

Following initial site preparation, residual clay soils are anticipated to be exposed across the proposed building area. The residual clays encountered within the referenced proposed building area typically exhibited medium to high plasticity characteristics.

The potential vertical rise of the onsite higher plasticity soils encountered in the borings was evaluated using the Texas Department of Transportation's test method TEX-124-E, Potential Vertical Rise (PVR). This method estimates the PVR of the clay soils based on the plasticity characteristics, thickness of the soil strata, and surcharge loads.

For this project site, an active zone of 8 feet was used in the calculations. The TxDOT method indicates a PVR on the order of 1¼ to 1½ inches for the soil moisture contents encountered at the time of drilling.

A generally accepted practice is an allowance for maximum vertical movement of 1-inch for grade supported slabs. The following table presents three building pad preparation alternates based on maximum PVR criteria of 1-inch, ¾-inch, or ½-inch. Specified thickness of lower plasticity structural fill below grade supported slabs will be dependent on what is considered tolerable total and differential vertical movements of the slab.

Design Maximum PVR (inches)	Recommended Minimum Lower Plasticity Structural Fill Below Grade Supported Slabs (feet)
~ 1	3.0
~ ¾	4.0
~ ½	5.5

Table 8: Estimated Potential Vertical Rise (PVR)

The structural fill placed within the building areas should extend at least 5 feet outside the perimeter of the proposed structures.

Following recommended undercutting and prior to fill placement, the exposed subgrade must be thoroughly evaluated and prepared in accordance with *Subgrade Evaluation and Preparation* section of this report.

4.4 Subgrade Evaluation and Preparation

Following recommended undercutting and prior to fill placement, the exposed subgrade should be scarified to depth of 8 inches, moisture conditioned to within range of 1 percent below to 3 percent above the optimum moisture content, and recompacted to at least 95 percent of the material's standard Proctor maximum dry density.

We recommend that the project geotechnical engineer or a qualified representative evaluate the subgrade after the site is prepared. Some unsuitable or unstable areas may be present in unexplored areas of the site. All areas that will require fill or that will support structures should be carefully proofrolled with a fully loaded, tandem-axle dump truck (20 to 25-ton), at the following times.

- After an area has been stripped and undercut as needed, and prior to the placement of any fill.
- After grading an area to the finished subgrade elevation in building and pavement areas.
- After areas have been exposed to any precipitation, and/or have been exposed for more than 48 hours.

Some instability may exist during construction, depending on climatic and other factors immediately preceding and during construction. If any soft or otherwise unsuitable soils are identified during the proofrolling process, they must be undercut or stabilized prior to fill placement, pavement construction, or floor slab construction. All unsuitable material identified during the construction shall be removed and replaced in accordance with the *Structural Fill* section of this report.

4.5 Pavement Subgrade Preparation

After initial site preparation and depending on final design grades, it is anticipated that a combination of residual lean clays, residual fat clays, and/or new structural fill will be exposed at subgrade level.

The onsite residual clay soils have a moderate to high swell potential and they pose a risk for pavement heave and development of tension cracks when soil moisture contents increase post-construction. Considering the higher plasticity characteristics of the clay soils, the proposed pavement sections should not be supported directly on the higher plasticity clay soils because of their moderate to high swell potential, and poor pavement support properties.

Two pavement subgrade preparation options are presented in this report:

- Lime stabilize the subgrade to depth of 8 inches; or
- Provide at least 12 inches of lower plasticity structural fill below the aggregate base course

4.5.1 Option I - Lime Stabilized Subgrade

Considering the anticipated subgrade conditions, we recommend chemical stabilization of the subgrade soils using lime to a depth of 8 inches. Chemical stabilization will reduce the shrink-swell potential, improve the pavement support properties of the subgrade soils, improve the durability, and provide for a stable work platform less susceptible to loss of strength and stability with soil moisture content increases.

Based on experience with soils similar to those encountered at the project site, estimated quantities of lime based on soil dry weight are tabulated below. Laboratory tests should be performed on bulk samples of onsite clay soils and a chemical additive provided by the supplier at the start of the construction phase to evaluate the optimum amount of stabilizing agent. We further recommend that the supplier of the proposed chemical additive submit a current chemical analysis report for review and approval by the geotechnical engineer.

Lime Stabilizing Agent	ODOT Specification [1]	Estimated Quantity of Stabilizing Agent, % of Soil Dry Weight
Quick Lime	307 & 706.02	4-5
Hydrated Lime	307 & 706.01	6-7

Table 9: Lime Stabilization Alternates

Notes:

1. ODOT – Oklahoma Department of Transportation, 2019 edition

Cement kiln dust (CKD) with high free lime content from pre-calciner plants, lime kiln dust (LKD), and carbide lime have also been successfully used with medium to high plasticity clay soils to reduce their plasticity and shrink-swell potential to within acceptable level. However, these types of chemical additive are by products and their composition varies depending on the source from which they are provided. Further laboratory testing is recommended to estimate needed concentrations for these types of chemical additive when considered for this project. Building & Earth can assist with this service prior to start of construction.

Chemical stabilization of the higher plasticity clay soils should be performed in accordance with the applicable specifications of the Oklahoma Standard Specifications for Highway Construction, 2019 edition.

4.5.2 Option II - Subgrade Comprised of Lower Plasticity Material

In lieu of lime stabilization, consideration can be given to providing at least 12 inches of lower plasticity material below the aggregate base course of the pavements. Structural fill proposed for use in pavement areas should have a 96-hour soaked CBR value of at least 4.

4.6 Structural Fill

Requirements for imported lower plasticity structural fill on this project are as follows:

Soil Type	USCS Classification	Property Requirements	Placement Location
Imported Lean Clay, Clayey Sand or Shale	CL, SC	LL<40, 7<PI<18, γ_d>100 pcf, P200>30%, Maximum 3" particle size in any dimension, CBR ≥ 4.0 for pavements	**Lower Plasticity Structural Fill** to be used for construction of building pad (min. 36 to 66" thick) and pavement subgrade preparation (min. 12" thick)
Proposed Lagoon Area lean clays and sandy silty clays	CL, CL-ML	Same as above for Imported Fill	**Suitable** for use as lower plasticity structural fill (see note 5)
Proposed Meat Processing Facility Area Residual Clays	CL, CH, CL-CH	Not Applicable	**Not suitable** for re-use as structural fill in proposed building and pavement areas due to the high plasticity characteristics. For lagoon liner construction, the CH soils may be suitable (see Note 6)

Table 10: Imported Structural Fill Requirements

Notes:

1. All structural fill should be free of vegetation, topsoil, and any other deleterious materials. The organic content of materials to be used for fill should be less than 3 percent.
2. LL indicates the soil Liquid Limit; PI indicates the soil Plasticity Index; γ_d indicates the maximum dry density as defined by the density standard outlined in the table below.
3. Laboratory testing of the soils proposed for fill must be performed to verify their conformance with the above recommendations.
4. Representative bulk samples for any and imported offsite materials are to be collected for soil classification and moisture-density relationship determination purposes as part of evaluating suitability for their intended use.
5. The onsite alluvial soils have a significant silt fraction. These types of soils are moisture sensitive, prone to losing strength and stability with slight soil moisture content increases. The contractor needs to maintain strict soil moisture control during and following fill placement to maintain stable subgrade conditions. In addition, portions of the alluvium were wet, or they had relatively high moisture contents. The contractor needs to anticipate the need for double handling and drying of the onsite alluvium when considered for use as structural fill.
6. Onsite fat clays from within the Meat Processing Facility site may be suitable for construction of a lagoon liner; however, supplemental laboratory testing, including flexible wall permeability on remolded test specimens is needed to assess the material's hydraulic conductivity at various levels of compaction and soil moisture contents.

Placement requirements for structural fill are as follows:

Specification	Requirement
Lift Thickness	Maximum loose lift thickness of 8 to 12 inches, depending on type of compaction equipment used.
Density	Minimum 95% of the standard Proctor maximum density (ASTM D698)
Moisture	±2% of the optimum moisture content as determined by ASTM D698
Density Testing Frequency	**Building and foundation areas**: One test per 2,500 square feet (SF) per lift with a minimum of three tests performed per lift **Pavement area**: One test per 5,000 SF per lift with a minimum of three tests performed per lift **Utility trenches**: One test per 150 linear feet per lift with a minimum of two tests performed per lift

Table 11: Structural Fill Placement Requirements

4.7 Excavation Considerations

4.7.1 Proposed Meat Processing Facility and Lift Station Areas

All excavations performed at the site should follow OSHA guidelines for temporary excavations. Excavated soils should be stockpiled according to OSHA regulations to limit the potential cave-in of soils.

Based on the subsurface conditions encountered in the test borings, the residuum was underlain by clayey shale and weathered shale units encountered at depths of about 8.5 to 12 feet below existing grades. We anticipate the weathered shale stratum can be excavated using a track hoe equipped with rock teeth. Excavation difficulty will increase with increasing depth into the shale unit.

Excavations extending in to the shale unit encountered at depths of about 14 to 17 feet in borings B-01, B-03 and B-07 will likely require a large track hoe, in good working condition and equipped with rock teeth and possibly a hydraulic hoe ram attachment.

The ability to excavate rock is a function of the material, the equipment used, the skill of the operator, the desired rate of removal and other factors. The contractor should review the borings logs and use their own method to evaluate excavation difficulty

4.7.2 Proposed Lagoon Area

Excavations extending to depths greater than 4 feet should be cut to a stable slope or be temporarily braced. Temporary slopes should be constructed in strict compliance with current OSHA excavation regulations.

Stockpiles should be placed well away from the edge of the excavations and their height controlled so that they do not surcharge the sides of the excavation. Surface drainage should be carefully controlled to prevent flow of water into the excavations.

The test borings encountered silty and sandy alluvium. Excavations extending in silty and sandy soils are prone to sloughing, localized slope instability, and erosion, even when left open for short periods of time.

Alluvial soils were underlain by limestone and shale units associated with the Wewoka Formation at depths of about 8.5 to 14 feet. Auger refusal was encountered in all borings drilled within the proposed lagoon area at depths of about 9 to 22.5 feet. A large track hoe, in good working condition and equipped with rock teeth and possibly a hydraulic hoe ram attachment, may be able to excavate the shale unit. ***Rock excavation techniques will be required when excavations extend into the auger refusal material (limestone unit).***

The ability to excavate hard rock is a function of the material, the equipment used, the skill of the operator, the desired rate of removal and other factors. The contractor should review the boring logs and should use his own method to evaluate excavation difficulty.

4.7.3 GROUNDWATER

Groundwater or perched water likely will be encountered in cuts during mass grading, in undercut areas for building pad construction, in utility trenches, and during construction of the lagoons.

It should be noted that fluctuations in the water level could occur due to seasonal variations in rainfall. The contractor must be prepared to remove groundwater seepage from excavations if encountered during construction. Excavations extending below groundwater levels will require dewatering systems (such as well points, sump pumps or trench drains). The contractor should evaluate the most economical and practical dewatering method.

4.8 UTILITY TRENCH BACKFILL

All utility trenches must be backfilled and compacted in the manner specified above for structural fill. It may be necessary to reduce the lift thickness to 4 to 6 inches to achieve compaction using hand-operated equipment.

At the perimeter wall crossings, we recommend that clay soils or a flowable fill be used to backfill the utility trench. The clay or flowable fill will act as a relatively impermeable plug reducing the risk of water migration from the outside into the interior of the building. The plug should be at least 36 inches wide and should extend below the perimeter walls to provide for a proper seal.

4.9 Landscaping and Drainage Consideration

The potential for soil moisture fluctuations within building areas and pavement subgrades should be reduced to lessen the potential of subgrade movement. Site grading should include positive drainage away from buildings and pavements.

Landscaping and irrigation immediately adjacent to building and pavements should be limited. Trees can develop large root systems which can draw water from subgrade soils, resulting in subsequent shrinkage of the soils. Excessive irrigation of landscaping poses a risk of saturating and softening soils and swelling of higher plasticity clay soils.

4.10 Wet Weather Construction

Excessive movement of construction equipment across the site during wet weather may result in ruts, which will collect rainwater, prolonging the time required to dry the subgrade soils.

During rainy periods, additional effort will be required to properly prepare the site and establish/maintain an acceptable subgrade. The difficulty will increase in areas where clay or silty soils are exposed at the subgrade elevation. Grading contractors typically postpone grading operations during wet weather to wait for conditions that are more favorable. Contractors can typically disk or aerate the upper soils to promote drying during intermittent periods of favorable weather. When deadlines restrict postponement of grading operations, additional measures such as undercutting and replacing saturated soils or stabilization can be utilized to facilitate placement of additional fill material.

5.0 SHALLOW FOUNDATIONS - PROPSOED MEAT PROCESSING FACILITY

Based on information provided to our office, we understand that the individual column loads will be on the order of 50 kips and wall loads of 2 to 4 kips per linear foot. ***If these preliminary loads are incorrect, our office should be contacted, such that our recommendations can be reviewed.***

Based on the conditions encountered during our field investigation and after our site preparation recommendations are implemented as previously described in the *Initial Site Preparation, Building Pad Preparation – Proposed Meat Processing Facility,* and *Subgrade Evaluation and Preparation* sections of this report, the proposed structure can be supported on conventional shallow foundations.

Based on the subsurface conditions encountered, and depending on the selected tolerable PVR Value, we anticipate that properly compacted and approved low plasticity structural fill and/or stiff residual clay soils will be exposed at footing bearing elevations within the proposed building area.

Footings bearing in new structural fill or undisturbed stiff residual clays can be dimensioned for a maximum net allowable bearing pressure of 2,500 pounds per square foot (psf).

The onsite lean to fat clays and fat clays exhibited higher plasticity characteristics; as such, the contractor should use caution during foundation construction as to not allow the bearing soils to dry while exposed to the elements. Drying of the clay soils would increase their swell potential and the subsequent risk of heave of footings. Desiccated soils will need to be undercut prior to placement of reinforcing steel and replaced with properly compacted, approved lower plasticity structural fill.

Total long-term settlement of spread footings designed and constructed as recommended above is estimated to be less than 1 inch. Differential settlement between any two points spaced 40 feet across the slab, or along continuous footings is estimated to be ½-inch or less.

Column footings should be at least 24 inches wide and strip footings should be at least 18 inches wide. These dimensions facilitate hand cleaning of footing subgrades disturbed by the excavation process and the placement of reinforcing steel. They also reduce the potential for localized punching shear failure. ***All exterior footings should bear at least 24 inches below the adjacent exterior grade.***

The following items should be considered during the preparation of construction documents and foundation installation:

- The geotechnical engineer of record should observe the exposed foundation bearing surfaces prior to concrete placement to verify that the conditions anticipated during the subsurface exploration are encountered.

- All bearing surfaces must be free of soft or loose soil and debris prior to placing concrete.
- The bottom surface of all footings should be level.
- Concrete should be placed the same day the excavations are completed and bearing materials verified by the engineer. If the excavations are left open for an extended period, or if the bearing surfaces are disturbed after the initial observation, then the bearing surfaces should be re-evaluated prior to concrete placement.
- Water should not be allowed to pond in foundation excavations prior to concrete placement or above the concrete after the foundation is completed.
- Wherever possible, the foundation concrete should be placed "neat", using the sides of the excavations as forms. Where this is not possible, the excavations created by forming the foundations must be backfilled with suitable structural fill and properly compacted.
- Grades around the building pad should be sloped to drain away from the building foundations.
- Roof drains should be routed away from the foundation soils. All drains should be collected in pipes or discharged outside buildings to prevent drainage into the subsurface soils.

6.0 FLOOR SLABS

Site development recommendations presented in this report should be followed to provide for subgrade conditions suitable for support of grade supported slabs. All grade supported slabs will be supported on a layer of lower plasticity structural fill material placed in accordance with *Building Pad Preparation Section* of this report, with thickness of 3 to 5.5 feet, depending on the tolerable PVR value.

6.1 OFFICE SPACE AREAS

Lightly loaded floor slabs with moisture sensitive floor covering are to be supported on a minimum four (4) inches thick compacted layer of free-draining, granular material, such as ASTM No. 57 stone. The purpose of this layer is to serve as a leveling course and act as a capillary break for moisture migration through the subgrade soil.

We recommend a minimum 10-mil thick vapor retarder meeting ASTM E 1745, Class C requirements be placed directly below the slab-on-grade floors. A higher quality vapor retarder (Class A or B) may be used if desired to further inhibit the migration of moisture vapor through the slab-on-grade and should be evaluated based on the floor covering and use. The vapor retarder should extend to the edge of the slab-on-grade floors and should be sealed at all seams and penetrations.

The slabs should be appropriately reinforced (if required) to support the proposed loads. With addition of the recommended granular material, an effective modulus of subgrade reaction of 125 pci can be used in the design of grade supported building floor slabs.

6.2 Slabs Subjected to Vehicular Traffic and Equipment Loads

Concrete slabs subjected to vehicular traffic and equipment loads should be supported on a minimum six (6) inches thick compacted layer of well graded crushed aggregate meeting Type "A" standard specifications outlined in the *Oklahoma Department of Transportation (ODOT) Standard Specification for Highway Construction (2019 edition)*. The purpose of this layer is to improve support for concrete slabs.

With addition of the crushed aggregate base course, an effective modulus of subgrade reaction of 150 pci can be used in the design of grade supported slabs.

7.0 LOADING DOCK WALLS

For this report we assume that loading dock walls will have maximum retained heights on the order of 4 feet. We recommended that all loading dock walls be backfilled with properly compacted and approved lower plasticity structural fill as outlined in *Structural Fill Section* of this report.

The following drained or undrained equivalent fluid pressures should be used to design the proposed stem walls. When designing for a drained condition, we recommend that a drainage blanket of ASTM No. 57 aggregate, with a minimum width of 12 inches be placed behind all walls. The clean aggregate should be wrapped in filter fabric to minimize intrusion of fines. A perforated drain line should be installed at the base of the wall and should extend to a sump where water can be collected and removed, or drains should discharge by gravity flow to a suitable outfall. Drained values should only be used when a drainage blanket with pipe drains are installed behind the wall.

When designing for an undrained condition, a drainage blanket will not be required. It should be noted that hydrostatic pressures are included in the undrained values presented in the table below.

At rest parameters, should be used to design walls that are not allowed to rotate or translate. Any surcharge loads must be included in the design.

Retained Material	Soil Parameter Values		Equivalent Fluid Unit Weights for Active & At-Rest Lateral Earth Pressures (pcf)			
	Wet Unit Weight (pcf)	Effective Angle of Internal Friction	At-Rest Condition		Active Condition	
			Drained	Undrained	Drained	Undrained
New Low Plasticity Structural Fill	125	28°	66	95	45	85

Table 12: Soil Parameters and Lateral Earth Pressure Values (Drained and Undrained Conditions)

Lateral pressures arising from surcharge loading should be added to the above earth pressures to determine the total lateral pressures. In addition, transient loads imposed on the retaining walls by construction equipment during backfilling should be taken into consideration. Excessively heavy grading equipment (that could impose temporary excessive lateral pressures) should not be allowed within 5 feet (horizontally) of the walls.

The above soil parameter and lateral earth pressure values assume the following:

- The wall backfill will be horizontal.
- Any backfill will be compacted to 95 percent of standard Proctor maximum dry density.
- No safety factor is included. The design of the loading dock walls should include a factor of safety of at least 1.5 against sliding and overturning using the above recommended values.
- Any surcharge is uniform.
- Wall friction is negligible

8.0 GENERAL SOIL CORROSIIY CONSIDEDRATIONS

Soil resistivity testing (ASTM G57) was performed in the field to determine the onsite soil's resistance to electrical current. Resistivity measurements were recorded using a Miller 400A analog resistance meter. The Wenner four-electrode soil resistivity method (ASTM G57) was performed with the electrodes spaced at intervals of 2, 5, 10, and 20 feet. The field resistivity results are presented in the following table.

Boring No.	Array Direction	Resistivity (Ω-cm)			
		Spacing (ft)			
		2	5	10	20
B-02	North-South	1,341	709	651	842
B-02	East-West	1,685	785	651	958
B-05	North-South	1,187	747	728	919
B-05	East-West	1,609	919	747	1,034

Table 13: Field Resistivity Test of Soil Results

Additionally, testing was conducted during our preliminary exploration to aid in determining the corrosivity of the existing residual soils. This conducted testing included pH, chloride content, and sulfate content. The results of the original testing are displayed in the following table.

Sample	pH	Chloride (ppm)	Sulfate (ppm)
B-02 (2.5 - 4.0)	6.81	133	1,270
B-05 (0.5 – 2.0)	6.17	<45.8	178

Table 14: Summary of Corrosion Test Results

The selected samples collected were considered acidic. Taking into consideration the field resistivity values detailed above, the in-situ materials can be expected to have a moderate to severe corrosion potential. Professional engineers, specialized in corrosion protection of underground steel structures, should perform a thorough evaluation of the soil conditions, and design a corrosion protection system.

The concentration of chloride ions in soils will also contribute to corrosion of steel in contact with soils. The chloride concentration at Borings B-02 and B-05 was 133 and less than the recordable limit of 45.8 parts per million (ppm). The presence of chloride ions typically will promote the corrosion process.

The water-soluble sulfate content of the soil samples collected was found to be 1,270 and 178 ppm. In accordance with table 4.3.1 of American Concrete Institute (ACI) 318, soils with less than 0.10% (1,000 ppm) of water-soluble sulfate per weight of soils have negligible sulfate exposure characteristics. Soils with 0.10% (1,000 ppm) to 0.20% (2,000 ppm) of water-soluble sulfate per weight of soils have a moderate exposure to sulfate characteristics.

9.0 LAGOON CONSIDERATIONS

We understand that new lagoon cells will be constructed as part of the planned construction. The precise locations, number of lagoon cells and their plan dimension and depth were not known at this time. We understand that design and construction of the lagoons may need to follow the standard specifications set forth by the Oklahoma Department of Environmental Quality (ODEQ).

Based on the subsurface conditions encountered in Borings B-08 through B-11, we anticipate that variable conditions will likely be encountered at the lagoon bottom. Alluvial soils comprised of lean clays and sand silty clays were encountered below topsoil and extended to depths of about 8.5 to 14 feet below existing ground surface. Alluvial clays encountered within the proposed lagoon areas typically exhibited medium stiff consistencies and low plasticity characteristics. Soft to medium stiff clays were encountered in borings B-08 and B-09 at a depth of about 8.5 feet.

Limestone and shale units associated with Wewoka Formation were encountered beneath the alluvial clays. Auger refusal was encountered in all borings drilled within the lagoon area at depths of about 9 to 22.5 feet.

Depending on the depth of the lagoon, alluvial soils, and limestone/shale are expected to be encountered within the lagoon walls. Groundwater was encountered in the lagoon borings at depths typically ranging from 7 to 10 feet below the ground surface. Delayed readings, seven days after completion of drilling, indicated groundwater stabilized at a level of about 6.8 feet in boring B-11. Borings B-08 and B-09 were dry due to cave-in and actual delayed water levels could not be determined in these borings at this time.

Design and construction of lagoon cells will need to consider the shallow groundwater conditions. In accordance with the referenced ODEQ standard specifications, maintain a 4-foot separation between the lagoon bottom and the highest known groundwater elevation. Groundwater monitoring using piezometers over a period of at least six (6) months is recommended to evaluate water fluctuations at the site.

In accordance with Oklahoma Department of Environmental Quality (ODEQ) Title 252, Chapter 656, Subchapter 11, Section 3, soil used in construction of the lagoon soil seal should have a hydraulic conductivity no greater than 10^{-7} cm/s, have a high content of fines, and be free of excessive gravel content.

The lagoon soils seal should be constructed of fat clay (CH) soils with a Plasticity Index (PI) greater than 30 and a Liquid Limit (LL) greater than 50. The clay soil should be free of any organics or any other deleterious materials and should be free of rock fragments. Any clay soil proposed for construction of the clay liner should be approved by the geotechnical engineer. As stated in the Structural Fill section of this report, the fat clay soils encountered in the proposed Meat Processing Facility area may be suitable for construction of a clay liner. Supplemental laboratory testing, including permeability on remolded test specimens, is recommended for further evaluate their suitability for intended use.

The required thickness of the lagoon soil seal will depend on the design depth of the lagoon cell, the hydraulic conductivity of the undisturbed soils or rock unit exposed in the bottom and sides of the lagoon cell, the hydraulic conductivity of clay soil used to construct the soil seal, the level of compaction specified, the soil moisture content of the clay soil at the time of placement and prior to filling the lagoon cell, and the degree of cracking that may occur within the soil seal due to wetting-drying and freeze-thaw cycles. As a minimum, the lagoon soil seal must have a thickness of 12 inches; however, the design engineer will need to determine the required thickness of the lagoon soil seal in order to satisfy the overall requirement for the seepage rate through the lagoon bottom and inside dike not to exceed 500 gal/day/acre (5.4×10^{-7} cm/s) at a water depth of 6 feet.

The lagoon soil seal should be constructed using a loose lift thickness of about 6 inches. The clay should be moisture conditioned to within a range of 0 to +4% of the optimum moisture content and compacted to at least 90% of the standard Proctor maximum dry density per ODEQ specifications (Building & Earth recommends that the clay liner be compacted to at least 95% of the standard Proctor maximum dry density with a moisture content range of +2 to +4% of the optimum moisture content). The specifications should state that both density and moisture requirements should be met. Density and moisture tests should be performed on each lift prior to placement of subsequent lifts.

Upon completing construction of the lagoon soil seal, care should be exercised to maintaining the soil moisture levels within the recommended range in order to limit the risk of crack development from desiccation of the clay soils when exposed to the elements. During winter construction, the lagoon soil seal should be protected from freeze-thaw cycles which can also promote crack development.

10.0 PAVEMENT CONSIDERATIONS

Specific traffic information was not provided. For pavement design purposes, we have assumed two levels of traffic shown in the table below, for commonly used pavement sections. If the pavement were a typical roadway, according to the "AASHTO Guide for Design of Pavement Structures, 1993", these pavement sections would be adequate for the following 18-Kip Equivalent Single Axle Load capacities:

Type	Assumed Equivalent Single Axle Loads (ESAL)
Standard Duty	160,000
Heavy Duty	550,000 (1)

Table 15: Assumed Traffic Volume

Notes:

1. For heavy duty pavements, we assumed that the pavements will be subjected to less than 30 loaded semi-tractor trailer trucks per day, for a seven-day work week, and a design life of 20 years.

In addition, we have assumed the following design parameters:

Design Criteria	Value
Design life (Years)	20
Terminal Serviceability	2.0
Reliability	85%
Initial Serviceability	4.2 (Flexible) 4.5 (Rigid)
Standard Deviation	0.45 (Flexible) 0.35 (Rigid)

Table 16: Assumed Design Parameters

Refer to the *Pavement Subgrade Preparation* section earlier in this report with recommendations to either stabilize the subgrade soils with lime to depth of 8 inches or providing for at least 12 inches of lower plasticity structural fill. The following recommended flexible and rigid pavement sections are based on the condition that one of these pavement subgrade preparation options was used.

All subgrade, base and pavement construction operations should meet minimum requirements of the Oklahoma Department of Transportation (ODOT), Standard Specifications for Highway Construction, dated 2019. The applicable sections of the specifications are identified as follows:

Material	Specification Section
Portland Cement Concrete Pavement	414 & 701
Bituminous Asphalt Wearing Layer	411 & 708
Bituminous Asphalt Binder Layer	411 & 708
Mineral Aggregate Base Materials	303 & 703
Lime Stabilized Subgrade	307 & 706

Table 17: ODOT Specification Sections

10.1 Flexible Pavement

The asphalt pavement sections described herein were designed using the "AASHTO Guide for Design of Pavement Structures, 1993". Alternative pavement sections were designed by establishing the structural numbers used for the AASHTO design system and substituting materials based upon structural equivalency as follows:

Material	Structural No.
Asphalt Concrete	0.42
Crushed Stone Base	0.14
Lime Stabilized Subgrade	0.05
Low Plasticity Structural Fill (minimum CBR of 4.0)	0.02

Table 18: Structural Equivalent Coefficient

Based on the materials encountered at the boring locations and after our recommendations for site preparation are implemented, flexible pavements at the subject site may be designed based on an estimated California Bearing Ratio (CBR) of 2.5. The following flexible pavement sections are based on the design parameters presented above:

Minimum Recommended Thickness (in)		Material
Standard Duty	Heavy Duty	
2.0	2.0	HMAC Surface Course (Superpave "S4")
2.5	4.5	HMAC Binder Course (Superpave "S3")
6.0	6.0	Crushed Aggregate Base (ODOT Type "A")

Table 19: Asphalt Pavement Recommendations

10.2 RIGID PAVEMENT

The following rigid pavement sections are based on the design parameters presented above. We assume a modulus of subgrade reaction (k) of 75 pci. We have assumed concrete elastic modulus (E_c) of 3.1 X 10^6 psi, and a concrete modulus of rupture (S'_c) of 600 psi.

Minimum Recommended Thickness (in)		Material
Standard Duty	Heavy Duty	
5.0	6.0	Portland Cement Concrete, f'_c=4,000 psi
4.0	6.0	Crushed Aggregate Base (ODOT Type "A")

Table 20: Rigid Pavement Recommendations

The concrete should be protected against moisture loss, rapid temperature fluctuations, and construction traffic for several days after placement. All pavements should be sloped for positive drainage. We suggest that a curing compound be applied after the concrete has been finished.

For access drive approaches, trash compactor pads, loading areas, and other pavement areas that are frequently subjected to high traffic loads with frequent braking and turning of wheels, consideration should be given to using a rigid pavement section comprised of 7 inches Portland cement concrete over 6 inches of limestone aggregate base.

In our professional opinion, a rigid pavement section will perform better than a flexible pavement for heavy duty pavements subjected to frequent heavy truck traffic, particularly in radius with frequent braking and turning of wheels. For heavy-duty rigid pavements subjected to repeat heavy traffic loading conditions, consideration should be given to providing dowels at all construction joints for improved load transfer between the concrete panels.

Although not referenced in the ODOT specifications, based on our experience with project sites in this region and anticipated traffic loads, we recommend Portland cement concrete should have a minimum 28-day compressive strength of 4,000 psi, maximum slump of 4 inches, and air content of 5 to 7 percent.

For rigid pavements, we recommend a jointing plan be developed to control cracking and help preclude surficial migration of water into the base course and subgrade. If a jointing plan includes widely spaced pattern (spacing typically greater than 30 times the slab thickness), consideration should be given to include steel reinforcement in rigid pavements, per Section 3.4 of the American Association of State Highway and

Transportation Officials (AASHTO) Guide for Design of Pavement Structures 1993, and Section 3.8 of the American Concrete Institute (ACI) Guide for the Design and Construction of Concrete Parking Lots. Additionally, we recommend the joints be sealed to further preclude surficial moisture migration into the underlying supporting soils.

All pavements should be sloped, approximately ¼ inch per foot, to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade and cause premature deterioration of the pavements as a result of loss of strength and stability. Periodic maintenance of the pavement should be anticipated. This should include sealing of cracks and joints and maintaining proper surface drainage to avoid ponding of water on or near the pavement areas.

11.0 SUBGRADE REHABILITATION

The subgrade soils often become disturbed during the period between initial site grading and construction of surface improvements. The amount and depth of disturbance will vary with soil type, weather conditions, construction traffic, and drainage.

The engineer should evaluate the subgrade soil during final grading and prior to stone placement to verify that the subgrade is suitable to receive pavement base or floor slabs. The final evaluation may include proofrolling or density tests.

Subgrade rehabilitation can become a point of controversy when different contractors are responsible for mass and final grading. The construction documents should specifically state which contractor will be responsible for maintaining and rehabilitating the subgrade. Rehabilitation may include wetting, mixing, and re-compacting soils that have dried excessively or drying soils that have become wet.

12.0 CONSTRUCTION MONITORING

Field verification of site conditions is an essential part of the services provided by the geotechnical consultant. To confirm our recommendations, it will be necessary for Building & Earth personnel to make periodic visits to the site during site grading. Typical construction monitoring services are listed below.

- Periodic observations and consultations by a member of our engineering staff during site grading
- Field density tests during structural fill placement on a continuous basis
- Observation and verification of the bearing surfaces exposed after foundation excavation

- Reinforcing steel inspections
- Inspections of structural masonry
- Molding and testing of concrete cylinders and grout specimens
- Structural steel inspections
- Monitoring and testing during fireproofing
- Sampling of asphalt for mix verification and coring for determination of in-place thickness and density

13.0 CLOSING AND LIMITATIONS

This report was prepared for Thompson Construction, Inc., for specific application to the subject project located in Okmulgee, Oklahoma. The information in this report is not transferable. This report should not be used for a different development on the same property without first being evaluated by the engineer.

The recommendations in this report were based on the information obtained from our field exploration and laboratory analysis. The data collected is representative of the locations tested. Variations are likely to occur at other locations throughout the site. Engineering judgment was applied in regards to conditions between borings. It will be necessary to confirm the anticipated subsurface conditions during construction.

This report has been prepared in accordance with generally accepted standards of geotechnical engineering practice. No other warranty is expressed or implied. In the event that changes are made, or anticipated to be made, to the nature, design, or location of the project as outlined in this report, Building & Earth must be informed of the changes and given the opportunity to either verify or modify the conclusions of this report in writing, or the recommendations of this report will no longer be valid.

The scope of services for this project did not include any environmental assessment of the site or identification of pollutants or hazardous materials or conditions. If the owner is concerned about environmental issues Building & Earth would be happy to provide an additional scope of services to address those concerns.

This report is intended for use during design and preparation of specifications and may not address all conditions at the site during construction. Contractors reviewing this information should acknowledge that this document is for design information only.

An article published by the Geoprofessional Business Association (GBA), titled *Important Information About Your Geotechnical Report*, has been included in the Appendix. We encourage all individuals to become familiar with the article to help manage risk.

Appendix Table of Contents

GEOTECHNICAL INVESTIGATION METHODOLOGIES

The subsurface exploration, which is the basis of the recommendations of this report, has been performed in accordance with industry standards. Detailed methodologies employed in the investigation are presented in the following sections.

DRILLING PROCEDURES – STANDARD PENETRATION TEST (ASTM D1586)

At each boring location, soil samples were obtained at standard sampling intervals with a split-spoon sampler. The borehole was first advanced to the sample depth by augering and the sampling tools were placed in the open hole. The sampler was then driven 18 inches into the ground with a 140-pound automatic hammer free-falling 30 inches. The number of blows required to drive the sampler each 6-inch increment was recorded. The initial increment is considered the "seating" blows, where the sampler penetrates loose or disturbed soil in the bottom of the borehole.

The blows required to penetrate the final two (2) increments are added together and are referred to as the Standard Penetration Test (SPT) N-value. The N-value, when properly evaluated, gives an indication of the soil's strength and ability to support structural loads. Many factors can affect the SPT N-value, so this result cannot be used exclusively to evaluate soil conditions.

The SPT testing was performed using a drill rig equipped with an automatic hammer. Automatic hammers mechanically control the height of the hammer drop, and doing so, deliver higher energy efficiency (90 to 99 % efficiency) than manual hammers (60 % efficiency) which are dropped using a manually operated rope and cathead system. Because historic data correlations were developed based on use of a manual hammer, it is necessary to adjust the N-values obtained using an automatic hammer to make these correlations valid. Therefore, an energy correction factor of 1.3 was applied to the recorded field N-values from the automatic hammer for the purpose of our evaluation. The N-values discussed or mentioned in this report and shown on the boring logs are recorded field values.

Samples retrieved from the boring locations were labeled and stored in plastic bags at the jobsite before being transported to our laboratory for analysis. The project engineer prepared Boring Logs summarizing the subsurface conditions at the boring locations.

UNDISTURBED SAMPLING

Soil samples are obtained using Shelby tube samplers. The Shelby tube is a three (3) inch diameter, thin walled sampling tube that allows for relatively undisturbed sampling of soil. The undisturbed or thin-walled tube sampling is conducted in general accordance with ASTM D1587.

The sampling procedure consists of augering to the sample depth, then cleaning out the open borehole and continuously pushing the thin-walled, metal Shelby tube into the soil. The Shelby tubes are carefully withdrawn from the borehole to reduce the possibility of disturbing the sample. The ends of the Shelby tube are sealed in the field and the tubes are transported to the laboratory for testing.

FIELD RESISTIVITY (ASTM G57)

Soil resistivity testing is performed in the field to determine the underlying soils resistance to electrical current. Resistivity measurements were recorded using a Miller 400A analog resistance meter. The Wenner four-electrode soil resistivity method (ASTM G57) was performed with the electrodes spaced at intervals of 2, 5, 10, and 20 feet. The field resistivity results ate presented in a table later in the Appendix.

BORING LOG DESCRIPTION

Building & Earth Sciences, Inc. used the gINT software program to prepare the attached boring logs. The gINT program provides the flexibility to custom design the boring logs to include the pertinent information from the subsurface exploration and results of our laboratory analysis. The soil and laboratory information included on our logs is summarized below:

DEPTH AND ELEVATION

The depth below the ground surface and the corresponding elevation are shown in the first two columns.

SAMPLE TYPE

The method used to collect the sample is shown. The typical sampling methods include Split Spoon Sampling, Shelby Tube Sampling, Grab Samples, and Rock Core. A key is provided at the bottom of the log showing the graphic symbol for each sample type.

SAMPLE NUMBER

Each sample collected is numbered sequentially.

BLOWS PER INCREMENT, REC%, RQD%

When Standard Split Spoon sampling is used, the blows required to drive the sampler each 6-inch increment are recorded and shown in column 5. When rock core is obtained the recovery ration (REC%) and Rock Quality Designation (RQD%) is recorded.

SOIL DATA

Column 6 is a graphic representation of four different soil parameters. Each of the parameters use the same graph, however, the values of the graph subdivisions vary with each parameter. Each parameter presented on column 6 is summarized below:

- N-value- The Standard Penetration Test N-value, obtained by adding the number of blows required to drive the sampler the final 12 inches, is recorded . The graph labels range from 0 to 50.
- Qu – Unconfined Compressive Strength estimate from the Pocket Penetrometer test in tons per square foot (tsf). The graph labels range from 0 to 5 tsf.
- Atterberg Limits – The Atterberg Limits are plotted with the plastic limit to the left, and liquid limit to the right, connected by a horizontal line. The difference in the plastic and liquid limits is referred to as the Plasticity Index. The Atterberg Limits test results are also included in the Remarks column on the far right of the boring log. The Atterberg Limits graph labels range from 0 to 100%.
- Moisture – The Natural Moisture Content of the soil sample as determined in our laboratory.

SOIL DESCRIPTION

The soil description prepared in accordance with ASTM D2488, Visual Description of Soil Samples. The Munsel Color chart is used to determine the soil color. Strata changes are indicated by a solid line, with the depth of the change indicated on the left side of the line and the elevation of the change indicated on the right side of the line. If subtle changes within a soil type occur, a broken line is used. The Boring Termination or Auger Refusal depth is shown as a solid line at the bottom of the boring.

GRAPHIC

The graphic representation of the soil type is shown. The graphic used for each soil type is related to the Unified Soil Classification chart. A chart showing the graphic associated with each soil classification is included.

REMARKS

Remarks regarding borehole observations, and additional information regarding the laboratory results and groundwater observations.

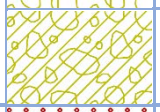
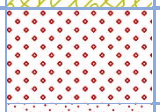
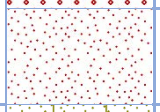
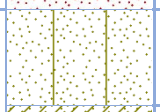
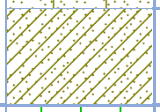
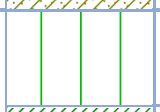
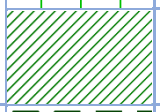
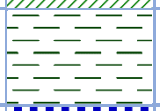
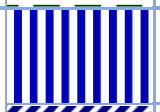
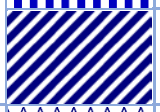
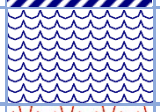
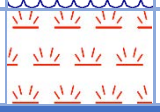
Major Divisions			Symbols		Group Name & Typical Description
			Lithology	Group	
Coarse Grained Soils *More than 50% of material is larger than No. 200 sieve size*	**Gravel and Gravelly Soils** *More than 50% of coarse fraction is larger than No. 4 sieve*	**Clean Gravels** *(Less than 5% fines)*		**GW**	*Well-graded gravels, gravel – sand mixtures, little or no fines*
				**GP**	*Poorly-graded gravels, gravel – sand mixtures, little or no fines*
		Gravels with Fines *(More than 12% fines)*		**GM**	*Silty gravels, gravel – sand – silt mixtures*
				**GC**	*Clayey gravels, gravel – sand – clay mixtures*
	Sand and Sandy Soils *More than 50% of coarse fraction is smaller than No. 4 sieve*	**Clean Sands** *(Less than 5% fines)*		**SW**	*Well-graded sands, gravelly sands, little or no fines*
				**SP**	*Poorly-graded sands, gravelly sands, little or no fines*
		Sands with Fines *(More than 12% fines)*		**SM**	*Silty sands, sand – silt mixtures*
				**SC**	*Clayey sands, sand – clay mixtures*
Fine Grained Soils *More than 50% of material is smaller than No. 200 sieve size*	**Silts and Clays** *Liquid Limit less than 50*	**Inorganic**		**ML**	*Inorganic silts and very find sands, rock flour, silty or clayey fine sands or clayey silt with slight plasticity*
				**CL**	*Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays*
		Organic		**OL**	*Organic silts and organic silty clays of low plasticity*
	Silts and Clays *Liquid Limit greater than 50*	**Inorganic**		**MH**	*Inorganic silts, micaceous or diatomaceous fine sand, or silty soils*
				**CH**	*Inorganic clays of high plasticity*
		Organic		**OH**	*Organic clays of medium to high plasticity, organic silts*
Highly Organic Soils				**PT**	*Peat, humus, swamp soils with high organic contents*

Table 1: Soil Classification Chart (based on ASTM D2487)

Building & Earth Sciences classifies soil in general accordance with the Unified Soil Classification System (USCS) presented in ASTM D2487. Table 1 and Figure 1 exemplify the general guidance of the USCS. Soil consistencies and relative densities are presented in general accordance with Terzaghi, Peck, & Mesri's (1996) method, as shown on Table 2, when quantitative field and/or laboratory data is available. Table 2 includes Consistency and Relative Density correlations with N-values obtained using either a manual hammer (60 percent efficiency) or automatic hammer (90 percent efficiency). The *Blows Per Increment* and *SPT N-values* displayed on the boring logs are the unaltered values measured in the field. When field and/or laboratory data is not available, we may classify soil in general accordance with the Visual Manual Procedure presented in ASTM D2488.

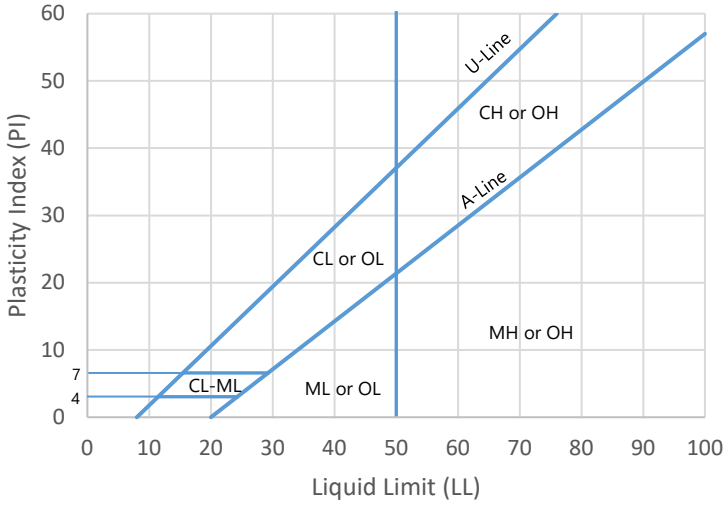


Figure 1: Plasticity Chart (based on ASTM D2487)

Non-cohesive: Coarse-Grained Soil			**Cohesive: Fine-Grained Soil**			
SPT Penetration (blows/foot)		**Relative Density**	**SPT Penetration (blows/foot)**		**Consistency**	**Estimated Range of Unconfined Compressive Strength (tsf)**
			Automatic Hammer*	Manual Hammer		
Automatic Hammer*	Manual Hammer		< 2	< 2	Very Soft	< 0.25
0 - 3	0 - 4	Very Loose	2 - 3	2 - 4	Soft	0.25 – 0.50
3 - 8	4 - 10	Loose	3 - 6	4 - 8	Medium Stiff	0.50 – 1.00
8 - 23	10 - 30	Medium Dense	6 - 12	8 - 15	Stiff	1.00 – 2.00
23 - 38	30 - 50	Dense	12 - 23	15 - 30	Very Stiff	2.00 – 4.00
> 38	> 50	Very Dense	> 23	> 30	Hard	> 4.00

Table 2: Soil Consistency and Relative Density (based on Terzaghi, Peck & Mesri, 1996)

* - Modified based on 80% hammer efficiency

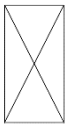
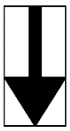
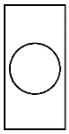
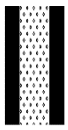
	Standard Penetration Test ASTM D1586 or AASHTO T-206		Dynamic Cone Penetrometer (Sower DCP) ASTM STP-399
	Shelby Tube Sampler ASTM D1587		No Sample Recovery
	Rock Core Sample ASTM D2113		Groundwater at Time of Drilling
	Auger Cuttings		Groundwater as Indicated

Table 1: Symbol Legend

Soil	Particle Size	U.S. Standard
Boulders	Larger than 300 mm	N.A.
Cobbles	300 mm to 75 mm	N.A.
Gravel	75 mm to 4.75 mm	3-inch to #4 sieve
Coarse	75 mm to 19 mm	3-inch to ¾-inch sieve
Fine	19 mm to 4.75 mm	¾-inch to #4 sieve
Sand	4.75 mm to 0.075 mm	#4 to #200 Sieve
Coarse	4.75 mm to 2 mm	#4 to #10 Sieve
Medium	2 mm to 0.425 mm	#10 to #40 Sieve
Fine	0.425 mm to 0.075 mm	#40 to #200 Sieve
Fines	Less than 0.075 mm	Passing #200 Sieve
Silt	Less than 5 µm	N.A.
Clay	Less than 2 µm	N.A.

Table 2: Standard Sieve Sizes

N-Value 	Standard Penetration Test Resistance calculated using ASTM D1586 or AASHTO T-206. Calculated as sum of original, field recorded values.	Atterberg Limits  PL LL	A measure of a soil's plasticity characteristics in general accordance with ASTM D4318. The soil Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL).
Qu	Unconfined compressive strength, typically estimated from a pocket penetrometer. Results are presented in tons per square foot (tsf).	% Moisture	Percent natural moisture content in general accordance with ASTM D2216.

Table 3: Soil Data

Hollow Stem Auger	Flights on the outside of the shaft advance soil cuttings to the surface. The hollow stem allows sampling through the middle of the auger flights.
Mud Rotary / Wash Bore	A cutting head advances the boring and discharges a drilling fluid to support the borehole and circulate cuttings to the surface.
Solid Flight Auger	Flights on the outside bring soil cuttings to the surface. Solid stem requires removal from borehole during sampling.
Hand Auger	Cylindrical bucket (typically 3-inch diameter and 8 inches long) attached to a metal rod and turned by human force.

Table 4: Soil Drilling Methods

Descriptor	Meaning
Trace	Likely less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

Table 5: Descriptors

Manual Hammer	The operator tightens and loosens the rope around a rotating drum assembly to lift and drop a sliding, 140-pound hammer falling 30 inches.
Automatic Trip Hammer	An automatic mechanism is used to lift and drop a sliding, 140-pound hammer falling 30 inches.
Dynamic Cone Penetrometer (Sower DCP) ASTM STP-399	Uses a 15-pound steel mass falling 20 inches to strike an anvil and cause penetration of a 1.5-inch diameter cone seated in the bottom of a hand augered borehole. The blows required to drive the embedded cone a depth of 1-3/4 inches have been correlated by others to N-values derived from the Standard Penetration Test (SPT).

Table 6: Sampling Methods

Non-plastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Table 7: Plasticity

Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible water.
Wet	Visible free water, usually soil is below water table.

Table 8: Moisture Condition

Stratified	Alternating layers of varying material or color with layers at least ½ inch thick.
Laminated	Alternating layers of varying material or color with layers less than ¼ inch thick.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensides	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Table 9: Structure

KEY TO HATCHES

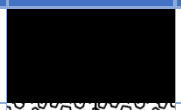
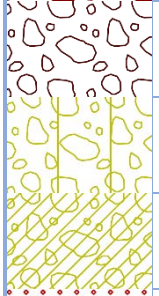
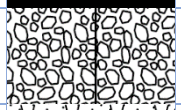
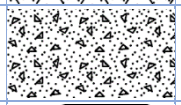
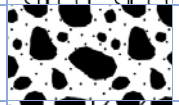
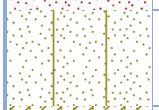
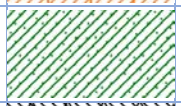
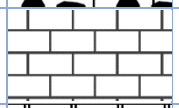
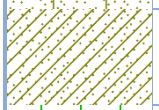
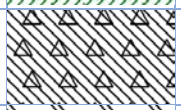
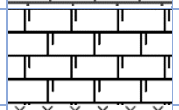
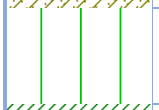
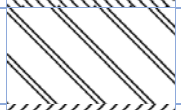
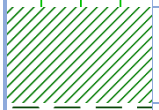
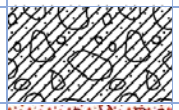
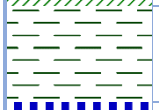
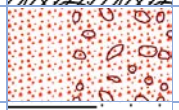
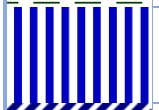
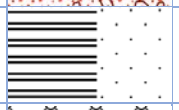
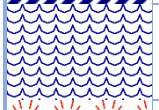
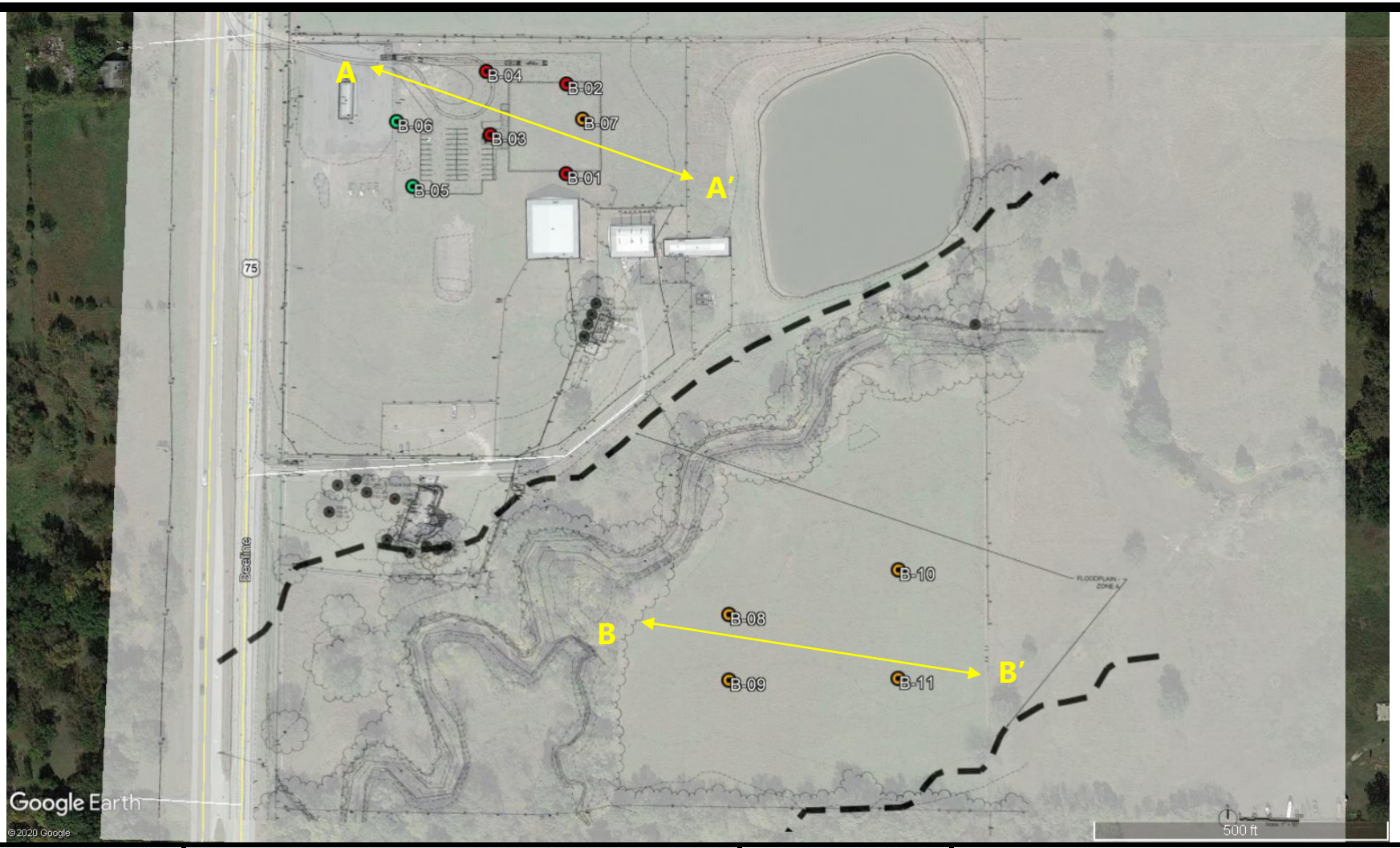
Hatch	Description	Hatch	Description	Hatch	Description
	***GW*** *- Well-graded gravels, gravel – sand mixtures, little or no fines*		*Asphalt*		*Clay with Gravel*
	***GP*** *- Poorly-graded gravels, gravel – sand mixtures, little or no fines*		*Aggregate Base*		*Sand with Gravel*
	GM *- Silty gravels, gravel – sand – silt mixtures*		*Topsoil*		*Silt with Gravel*
	GC *- Clayey gravels, gravel – sand – clay mixtures*		*Concrete*		*Gravel with Sand*
	***SW*** *- Well-graded sands, gravelly sands, little or no fines*		*Coal*		*Gravel with Clay*
	***SP*** *- Poorly-graded sands, gravelly sands, little or no fines*		***CL-ML*** *- Silty Clay*		*Gravel with Silt*
	***SM*** *- Silty sands, sand – silt mixtures*		*Sandy Clay*		*Limestone*
	***SC*** *- Clayey sands, sand – clay mixtures*		*Clayey Chert*		*Chalk*
	***ML*** *- Inorganic silts and very find sands, rock flour, silty or clayey fine sands or clayey silt with slight plasticity*		*Low and High Plasticity Clay*		*Siltstone*
	***CL*** *- Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays*		*Low Plasticity Silt and Clay*		*Till*
	***OL*** *- Organic silts and organic silty clays of low plasticity*		*High Plasticity Silt and Clay*		*Sandy Clay with Cobbles and Boulders*
	***MH*** *- Inorganic silts, micaceous or diatomaceous fine sand, or silty soils*		*Fill*		*Sandstone with Shale*
	***CH*** *- Inorganic clays of high plasticity*		*Weathered Rock*		*Coral*
	***OH*** *- Organic clays of medium to high plasticity, organic silts*		*Sandstone*		*Boulders and Cobbles*
	PT *- Peat, humus, swamp soils with high organic contents*		*Shale*		*Soil and Weathered Rock*

Table 1: Key to Hatches Used for Boring Logs and Soil Profiles

BORING LOCATION PLAN

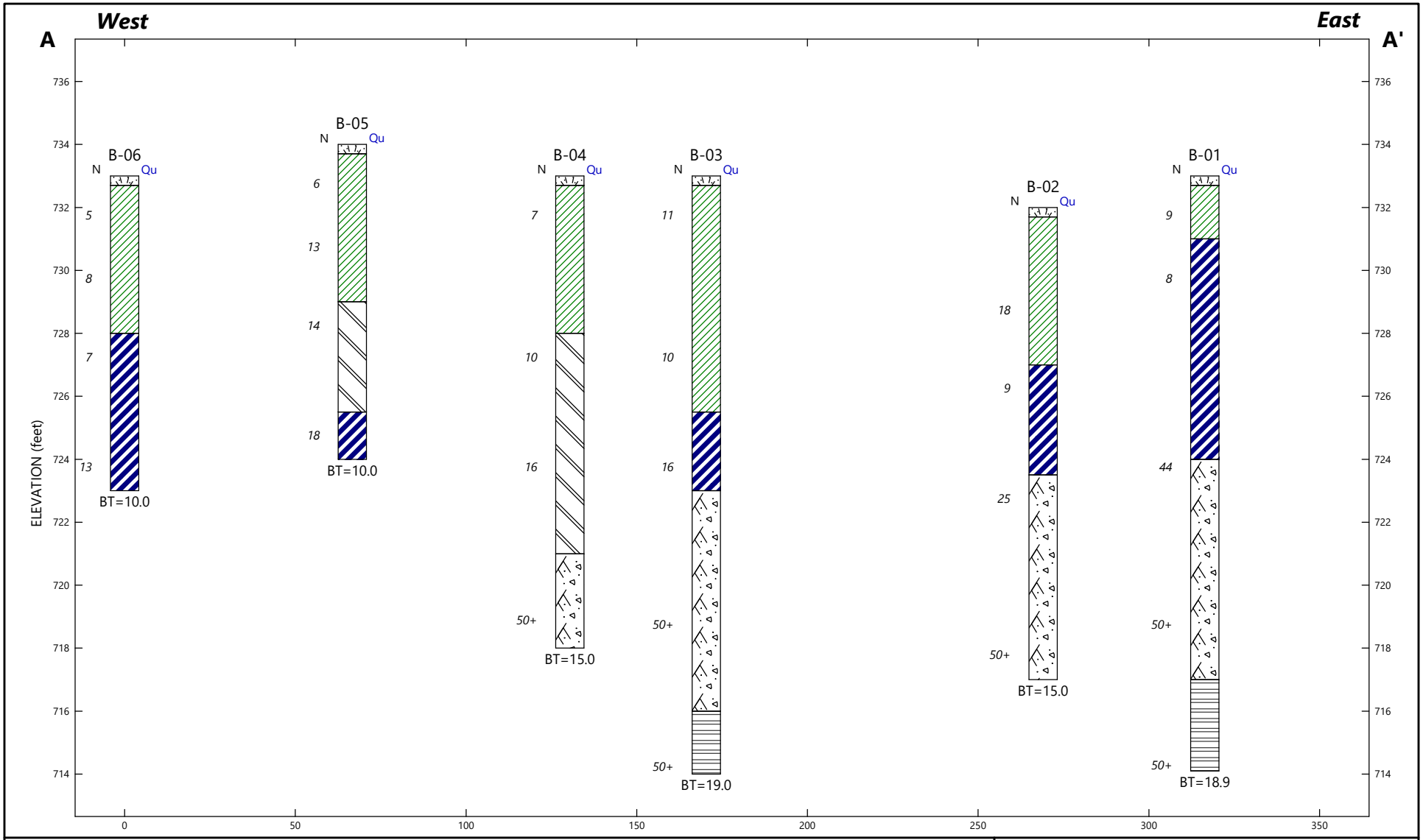


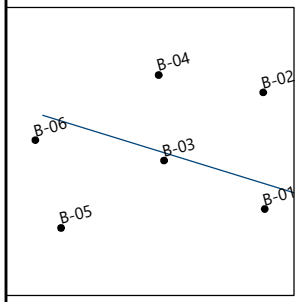
REFERENCE USED TO PRODUCE THIS DRAWING: Google Earth Satellite Imagery Dated October 27, 2018 with Site Plan overlay, unnamed and undated	**BORING LOCATION PLAN**		**DATE: 9/4/2020**
	PROJECT NO. OK200205	**PROJECT NAME / LOCATION:** MCN – Meat Processing Facility Okmulgee, OK	**SCALE:** As Shown

BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

SUBSURFACE PROFILES





Site Map Scale 1 inch equals 255 feet

Key to Hatches

- Topsoil
- USCS Low Plasticity Clay
- USCS High Plasticity Clay
- Weathered Rock
- Shale
- USCS Low to High Plasticity Clay

Legend

BT=Boring Termination, TPT=Test Pit Terminated
AR=Auger Refusal, ER=Excavation Refusal
N=Standard Penetration Test N-Value
Qu=Unconfined compressive strength estimate from pocket penetrometer test (tsf)
Water Level Reading at time of drilling.
Water Level Reading after drilling.

0 — 41
Horizontal Scale (feet)
Vertical Exaggeration: 9x

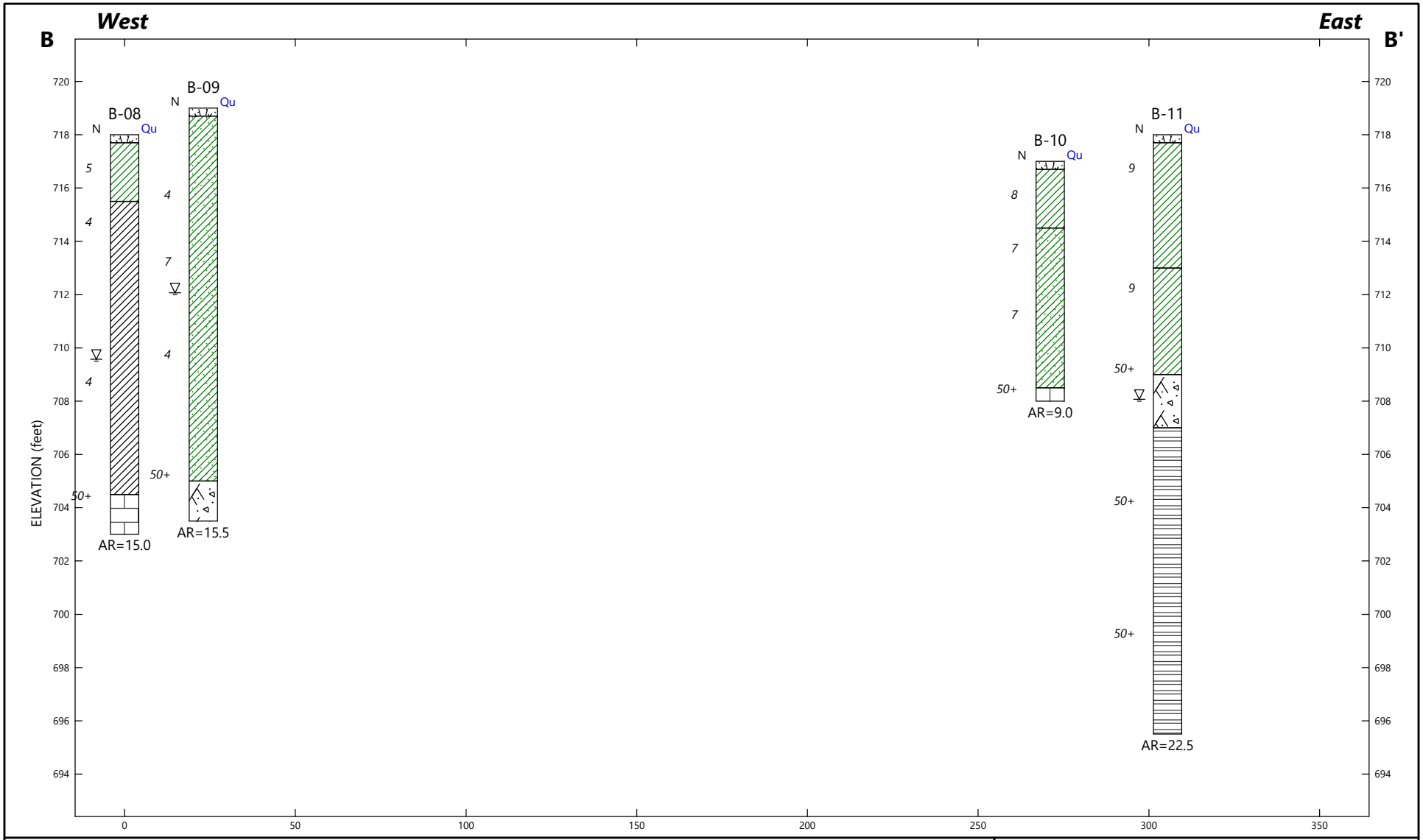
Building & Earth Sciences, Inc.
8200 N Classen Blvd., Suite 116, Oklahoma City, OK 73114

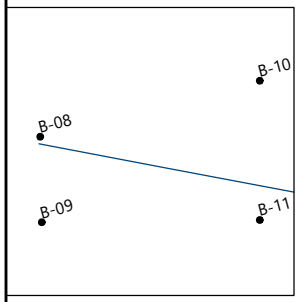
MCN Meat Processing Facility
Okmulgee, OK

A-A': Subsurface Profile

PROJECT NO: OK200205	PLATE NO: A-1	DATE: 9/17/20

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers





Site Map Scale 1 inch equals 255 feet

Key to Hatches

- Topsoil
- Limestone
- Shale
- USCS Low Plasticity Clay
- USCS Low Plasticity Sandy Clay
- USCS Low Plasticity Silty Clay
- Weathered Rock

Legend

BT=Boring Termination, TPT=Test Pit Terminated
AR=Auger Refusal, ER=Excavation Refusal
N=Standard Penetration Test N-Value
Qu=Unconfined compressive strength estimate from pocket penetrometer test (tsf)
Water Level Reading at time of drilling.
Water Level Reading after drilling.

0 — 41

Horizontal Scale (feet)
Vertical Exaggeration: 8x

Building & Earth Sciences, Inc.
1403 S 70th East Avenue, Tulsa, OK 74112

MCN Meat Processing Facility
Okmulgee, OK

B-B': Subsurface Profile

PROJECT NO: OK200205	PLATE NO: B-1	DATE: 9/17/20

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

BORING LOGS

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

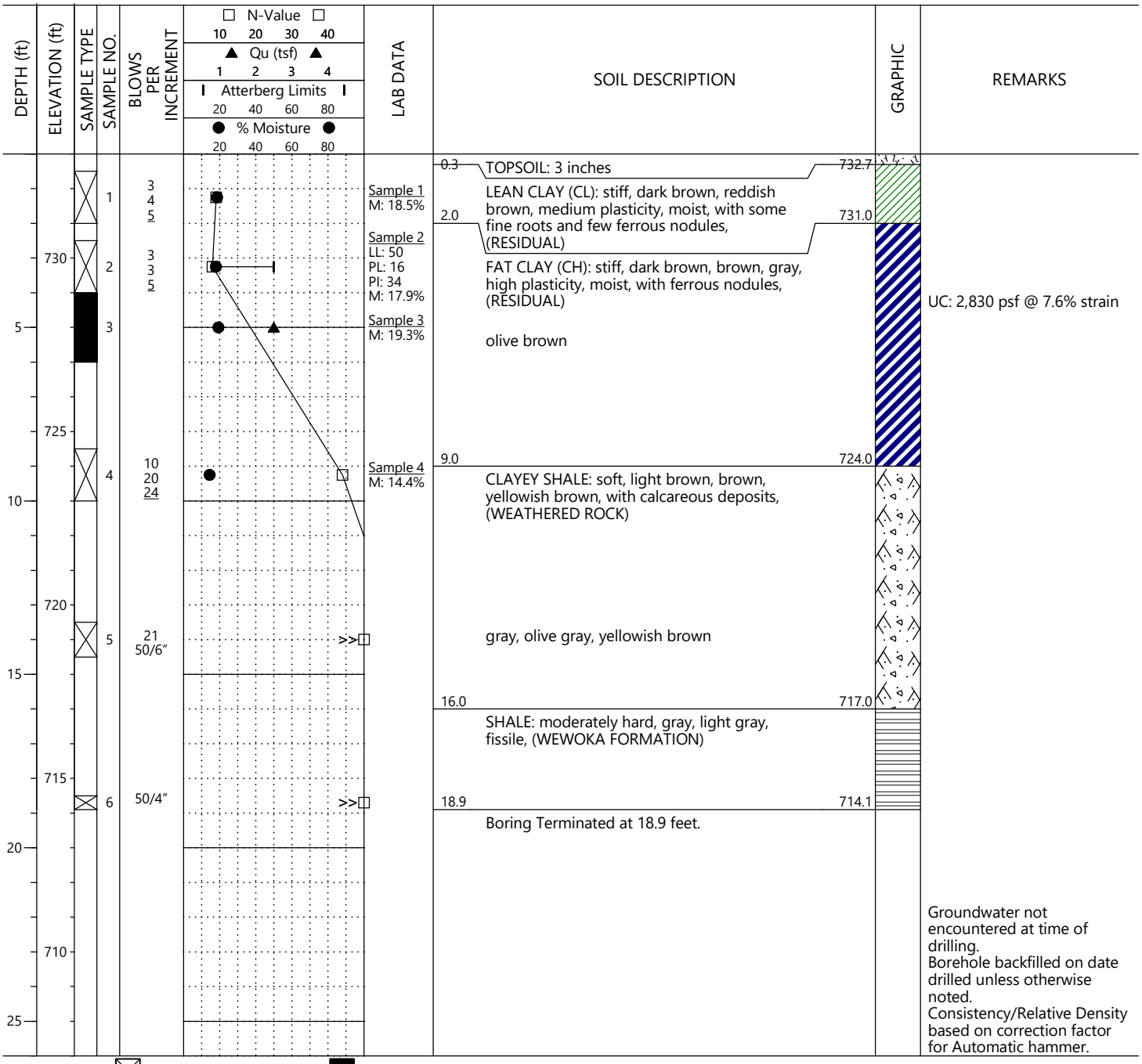
LOG OF BORING

Designation: B-01

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	733
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	SE corner of proposed building	LOGGED BY:	Antony Atencio



SAMPLE TYPE ☒ Split Spoon ■ Shelby Tube

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-02

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/2/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Cloudy
EQUIPMENT USED:	Diedrich D50	ELEVATION:	732
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	NE corner of proposed building	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0	732		1			Sample 1 M: 20.9%	0.3 TOPSOIL: 3 inches (731.7) LEAN CLAY (CL): very stiff, dark brown, grayish brown, medium plasticity, moist, with some fine roots and trace sandstone fragments, (RESIDUAL)		
	730		2	8 9 9		Sample 2 M: 15.7%			
5			3	3 4 5		Sample 3 LL: 50 PL: 15 PI: 35 M: 28.4%	5.0 (727.0) FAT CLAY (CH): stiff, dark brown, brown, yellowish brown, high plasticity, moist, (RESIDUAL)		
	725		4	5 9 16		Sample 4 M: 16.7%	9.5 (722.5) CLAYEY SHALE: soft, brown, yellowish brown, light gray, (WEATHERED ROCK)		
10	720		5	24 29 50/5"	>>		olive gray		
15							14.9 (717.1) Boring Terminated at 14.9 feet.		
	715								
20	710								Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
25									

SAMPLE TYPE ■ Shelby Tube ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-03

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	733
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	Center of proposed building	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0							0.3 TOPSOIL: 3 inches (732.7)		
			1	3 4 7		Sample 1 LL: 35 PL: 16 PI: 19 M: 13.0%	LEAN CLAY (CL): stiff, dark brown, reddish brown, grayish brown, medium plasticity, moist, with some fine roots, (RESIDUAL)		UC: 4,070 psf @ 2.5% strain
	730		2			Sample 2 M: 15.9%	very stiff		
5							5.0 (728.0)		
			3	4 4 6		Sample 3 M: 22.9%	LEAN TO FAT CLAY (CL-CH): stiff, olive brown, yellowish brown, medium to high plasticity, moist, (RESIDUAL)		
							7.5 (725.5)		
	725		4	6 7 9		Sample 4 M: 27.0%	FAT CLAY (CH): very stiff, yellowish brown, olive gray, bluish gray, high plasticity, moist, (RESIDUAL)		
10							10.0 (723.0)		
							WEATHERED SHALE: soft, light yellowish brown, brown, (WEATHERED ROCK)		
	720		5	19 34 50/6"	>>				
15							17.0 (716.0)		
	715						SHALE: soft to moderately hard, gray, light gray, fissile, (WEWOKA FORMATION)		
			6	50/5"	>>		18.9 (714.1)		
20							Boring Terminated at 18.9 feet.		
	710								Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
25									

SAMPLE TYPE ☒ Split Spoon ■ Shelby Tube

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-04

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/2/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Cloudy
EQUIPMENT USED:	Diedrich D50	ELEVATION:	733
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	NW corner of north area of proposed building	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0	733						0.3 TOPSOIL: 3 inches (732.7)		
		Split Spoon	1	2, 3, 4		Sample 1 M: 19.0%	LEAN CLAY (CL): stiff, dark brown, medium plasticity, moist, with fine roots, (RESIDUAL)		No recovery on Shelby sample. Tube broke in auger
	730	Shelby Tube	2						
5		Split Spoon	3	4, 4, 6		Sample 3 M: 21.9%	5.0 (728.0) LEAN TO FAT CLAY (CL-CH): stiff, olive brown, olive, yellowish brown, medium to high plasticity, moist, with trace weathered sandstone fragments, (RESIDUAL)		
	725	Split Spoon	4	5, 6, 10		Sample 4 M: 19.8%	very stiff, light brown, gray, light yellowish brown, with ferrous staining, shaley		
10							12.0 (721.0)		
	720	Split Spoon	5	24, 33, 50/3"	>>		CLAYEY SHALE: soft, light brown, olive brown, (WEATHERED ROCK)		
15							14.7 (718.3) Boring Terminated at 14.7 feet.		
	715								
20									
	710								
25									

Groundwater not encountered at time of drilling.
Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon ■ Shelby Tube

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-05

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	734
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	South drive area	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
							0.3 TOPSOIL: 3 inches (733.7)		
			1	2 2 4		Sample 1 M: 23.1%	LEAN CLAY (CL): medium stiff to stiff, dark brown, low plasticity, moist, with roots, (RESIDUAL)		
			2	4 5 8		Sample 2 M: 21.3%	very stiff, brown, reddish brown		
	730						5.0 (729.0)		
5			3	5 6 8		Sample 3 M: 22.7%	LEAN TO FAT CLAY (CL-CH): very stiff, dark brown, brown, dark grayish brown, medium to high plasticity, moist, (RESIDUAL)		
							8.5 (725.5)		
	725		4	5 8 10		Sample 4 M: 23.6%	FAT CLAY (CH): very stiff, yellowish brown, brown, olive brown, high plasticity, moist, (RESIDUAL)		
10							10.0 (724.0)		
							Boring Terminated at 10 feet.		
	720								
15									
	715								
20									
	710								
25									

Groundwater not encountered at time of drilling.
Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

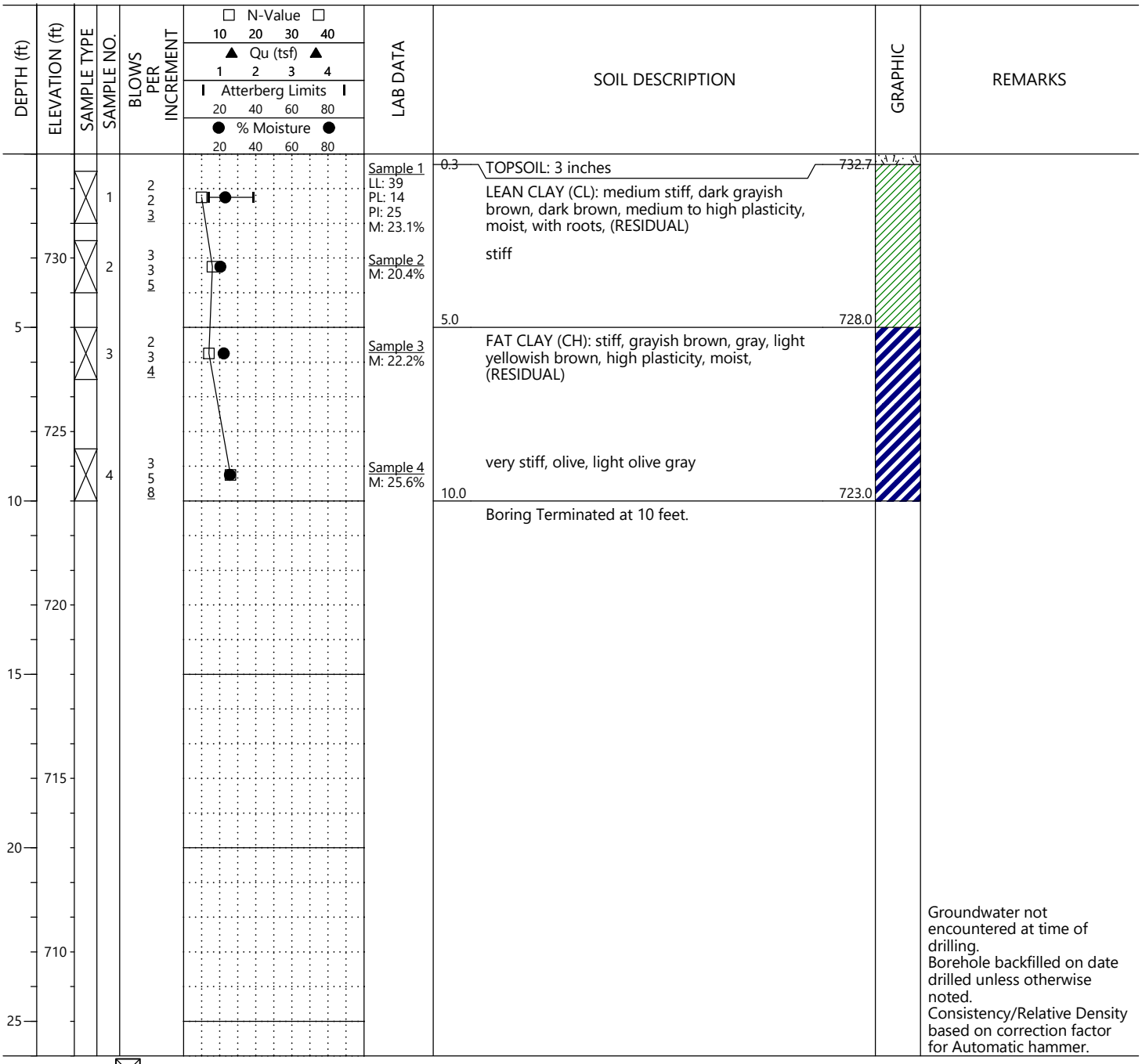
Designation: B-06

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: MCN Meat Processing Facility
PROJECT NUMBER: OK200205
DRILLING METHOD: Hollow Stem Auger
EQUIPMENT USED: Diedrich D50
HAMMER TYPE: Automatic
BORING LOCATION: North drive area

LOCATION: Okmulgee, OK
DATE DRILLED: 9/2/20
WEATHER: Cloudy
ELEVATION: 733
DRILL CREW: Mohawk
LOGGED BY: Antony Atencio



SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

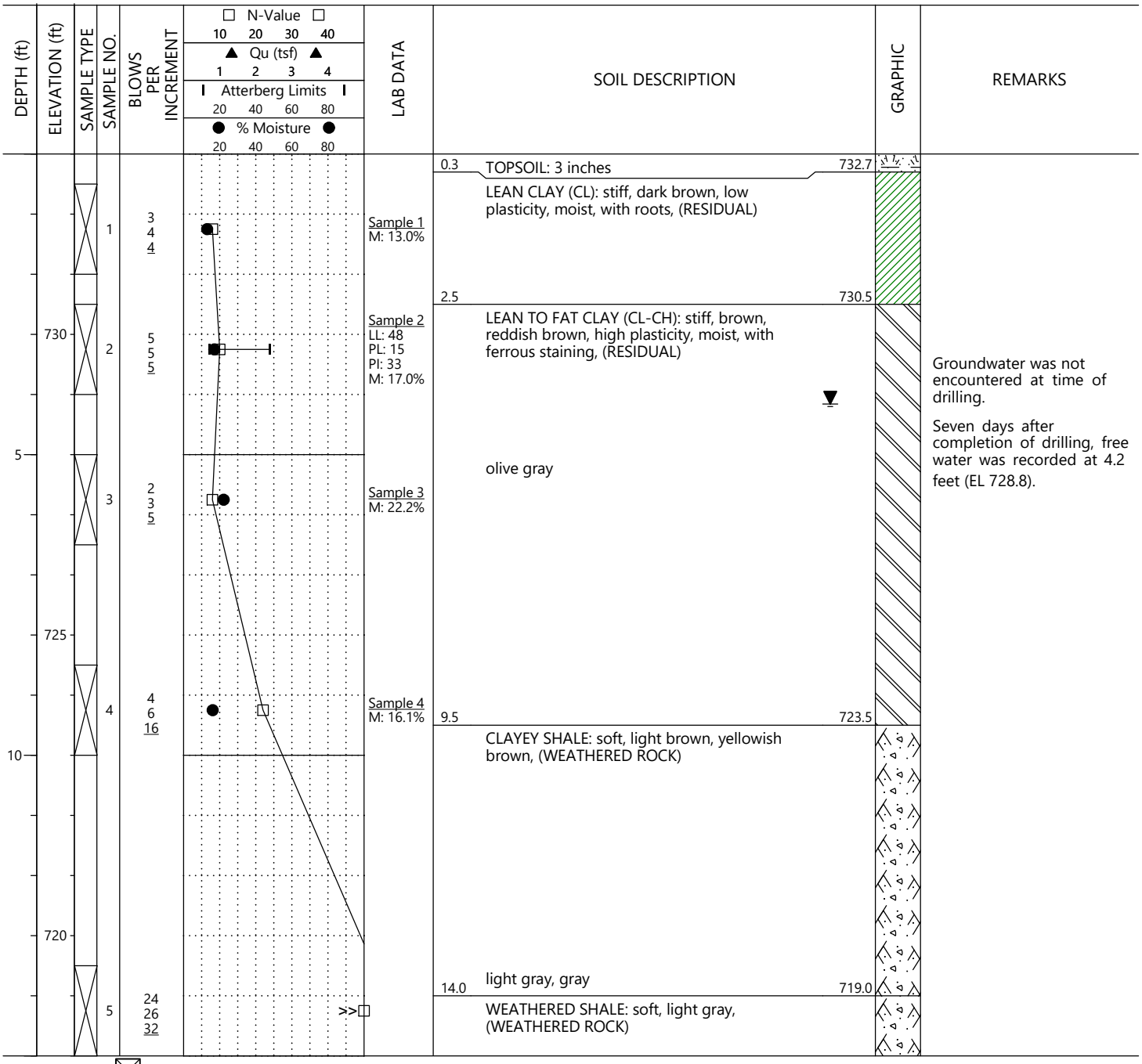
BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-07

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/2/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Cloudy
EQUIPMENT USED:	Diedrich D50	ELEVATION:	733
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	Proposed lift station	LOGGED BY:	Antony Atencio



SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-07

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/2/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Cloudy
EQUIPMENT USED:	Diedrich D50	ELEVATION:	733
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	Proposed lift station	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
							WEATHERED SHALE: soft, light gray, (WEATHERED ROCK)*(continued from 14.0 feet.)*		
							17.0 / 716.0		
							SHALE: soft to moderately hard, gray, light gray, (WEWOKA FORMATION)		
	715								
		⊠	6	50/5"	>>				
20									Hard drilling
	710								
		⊠	7	50/5"	>>				
							23.9 / 709.1		
							Boring Terminated at 23.9 feet.		Monitoring well installed
25									
	705								Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ⊠ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-08

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	718
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	North area of proposed western lagoon	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0							0.3 TOPSOIL: 3 inches (717.7)		
			1	2 2 3		Sample 1 M: 16.1%	LEAN CLAY (CL): medium stiff, dark brown, medium plasticity, moist, with roots, (ALLUVIAL)		
	715		2	3 2 2		Sample 2 LL: 21 PL: 14 PI: 7 M: 15.2% F: 55.8%	2.5 (715.5) SANDY SILTY CLAY (CL-ML): medium stiff, reddish brown, low plasticity, moist, with roots, (ALLUVIAL)		
5			3			Sample 3 M: 17.6%			
	710						wet, with silty sand seams and lenses ▽		Groundwater encountered at 8.5 feet (EL 709.5) at time of drilling.
			4	1 2 2		Sample 4 M: 19.2%	soft to medium stiff		
10									
	705		5	50/1"	>>		13.5 (704.5) LIMESTONE: hard, gray, light gray, with minor shale and fossils, (WEWOKA FORMATION)		
15							15.0 (703.0) Auger Refusal at 15 feet.		
	700								
20									
	695								Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
25									

SAMPLE TYPE ☒ Split Spoon ■ Shelby Tube

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-09

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	719
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	South area of proposed western lagoon	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0			1			Sample 1 M: 9.9%	0.3 TOPSOIL: 3 inches 718.7 SANDY LEAN CLAY (CL): medium stiff, reddish brown, light brown, low plasticity, dry to moist, with black ferrous staining and silty sand seams and lenses, (ALLUVIAL)		
			2	2 2 2		Sample 2 M: 13.9%	moist		
	715								
5			3	3 3 4		Sample 3 M: 12.2%			Groundwater encountered at 7 feet (EL 712) at time of drilling.
	710		4	1 2 2		Sample 4 LL: 25 PL: 12 PI: 13 M: 21.2% F: 62.7%	light gray, yellowish red, wet, with sand		
10									
	705		5	50/6"	>>		14.0 705.0 WEATHERED SHALE: soft, dark gray, calcareous, with limestone seams, (WEATHERED ROCK)		
15							15.5 703.5 Auger Refusal at 15.5 feet.		Apparant Limestone
	700								
20									
	695								Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
25									

SAMPLE TYPE ■ Shelby Tube ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-10

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	717
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	North area of proposed eastern lagoon	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0	715		1	2 4 4		Sample 1 M: 10.7%	0.3 TOPSOIL: 3 inches (716.7)		
							LEAN CLAY (CL): stiff, dark brown, reddish brown, low plasticity, dry to moist, with some fine roots, (ALLUVIAL)		
			2	2 3 4		Sample 2 M: 13.6%	2.5 (714.5) SANDY LEAN CLAY (CL): stiff, brown, reddish brown, yellowish brown, low plasticity, moist, (ALLUVIAL)		
5	710		3	3 3 4		Sample 3 LL: 22 PL: 14 PI: 8 M: 16.6% F: 53.3%	reddish yellow, light gray		
			4	50/0.1"	>>		8.5 (708.5) 9.0 (708.0) LIMESTONE: hard, gray, light gray, (WEWOKA FORMATION)		
10	705						Auger Refusal at 9 feet.		
15	700								
20	695								Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
25									

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-11

Sheet 1 of 1

1403 S 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	MCN Meat Processing Facility	LOCATION:	Okmulgee, OK
PROJECT NUMBER:	OK200205	DATE DRILLED:	9/4/20
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Sunny
EQUIPMENT USED:	Diedrich D50	ELEVATION:	718
HAMMER TYPE:	Automatic	DRILL CREW:	Mohawk
BORING LOCATION:	South area of proposed eastern lagoon	LOGGED BY:	Antony Atencio

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value / Qu (tsf) / Atterberg Limits / % Moisture	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0							0.3 TOPSOIL: 3 inches (717.7)		
	715		1	3 4 5		Sample 1 M: 14.1%	LEAN CLAY (CL): stiff, dark grayish brown, low plasticity, moist, with roots, (ALLUVIAL)		
			2			Sample 2 M: 17.3%			
5			3	3 4 5		Sample 3 M: 17.9%	5.0 (713.0) LEAN CLAY (CL): stiff, reddish yellow, gray, medium plasticity, moist, with black ferrous staining and trace fine roots, (ALLUVIAL) ▼		Groundwater encountered at 10 feet (EL 708) at time of drilling and stabilized at 6.8 feet (EL 711.2).
	710		4	50/6"	>>	Sample 4 M: 13.8%	9.0 (709.0) WEATHERED SANDSTONE: poorly cemented, yellowish brown, light gray, brown, (WEATHERED ROCK) ▽		
10							11.0 (707.0) SHALE: soft to moderately hard, dark gray, light gray, slightly weathered, fissile, (WEWOKA FORMATION)		
	705		5	50/5"	>>				
15									
	700		6	50/4"	>>		with some thin limestone seams		
20							22.5 (695.5)		
	695						Auger Refusal at 22.5 feet.		Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
25									

SAMPLE TYPE ☒ Split Spoon ■ Shelby Tube

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX

LABORATORY TEST PROCEDURES

A brief description of the laboratory tests performed is provided in the following sections.

DESCRIPTION OF SOILS (VISUAL-MANUAL PROCEDURE) (ASTM D2488)

The soil samples were visually examined by our engineer and soil descriptions were provided. Representative samples were then selected and tested in accordance with the aforementioned laboratory-testing program to determine soil classifications and engineering properties. This data was used to correlate our visual descriptions with the Unified Soil Classification System (USCS).

POCKET PENETROMETER

Pocket Penetrometer tests were performed on cohesive soil samples. The pocket penetrometer provides a consistency classification, and an indication of the soils unconfined compressive strength (Qu).

NATURAL MOISTURE CONTENT (ASTM D2216)

Natural moisture contents (M%) were determined on selected samples. The natural moisture content is the ratio, expressed as a percentage, of the weight of water in a given amount of soil to the weight of solid particles.

ATTERBERG LIMITS (ASTM D4318)

The Atterberg Limits test was performed to evaluate the soil's plasticity characteristics. The soil Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid. The Plastic Limit is the moisture content at which the soil is between "plastic" and the semi-solid stage. The Plasticity Index (PI = LL - PL) is a frequently used indicator for a soil's potential for volume change. Typically, a soil's potential for volume change increases with higher plasticity indices.

MATERIAL FINER THAN NO. 200 SIEVE BY WASHING (ASTM D1140)

Grain-size tests were performed to determine the partial soil particle size distribution. The amount of material finer than the openings on the No. 200 sieve (0.075 mm) was determined by washing soil over the No. 200 sieve. The results of wash #200 tests are presented on the boring logs included in this report and in the table of laboratory test results.

UNCONFINED COMPRESSION TEST ON SOIL SAMPLES (ASTM D2166)

Unconfined compressive strength tests are performed on relatively undisturbed samples extruded from Shelby tubes. The unconfined compressive strength test provides indication of the approximate strength of cohesive soils in terms of total stresses. A tube sample is extruded and trimmed square to prepare a specimen with length to diameter ratio between 2.0 and 2.5. The specimen is placed in a loading device and subjected to a uniaxial compressive load. Load and deformation readings were recorded during each test. The sample is loaded until the load values decrease with increasing strain, or until the sample has experienced 15% strain. The unconfined compressive strength (Qu) is reported as the maximum stress value or stress value recorded at 15% strain, whichever occurred first.

WATER SOLUBLE CHLORIDE AND SULFATE, AND PH

Representative samples of soil and groundwater are collected and analyzed for sulfates, chlorides, and pH to evaluate the corrosion potential of the site. These tests were performed in order to obtain information regarding the soil's relative ability to transmit electrical currents and thus, corrode metals places in contact with it. Soil sulfate content tests were performed on the samples to evaluate sulfate attack on buried concrete. The test results are compared to published standards applicable to the project construction for assignment of corrosion potential ratings.

LABORATORY TEST RESULTS

The results of the laboratory testing are presented in the following tables.

BORING NO.	DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE	CLASSIFICATION
B-01	0.5 - 2.0	18.5					
B-01	2.5 - 4.0	17.9	50	16	34		
B-01	4.0 - 6.0	19.3					
B-01	8.5 - 10.0	14.4					
B-02	0.0 - 2.0	20.9					
B-02	2.5 - 4.0	15.7					
B-02	5.0 - 6.5	28.4	50	15	35		
B-02	8.5 - 10.0	16.7					
B-03	0.5 - 2.0	13.0	35	16	19		
B-03	2.0 - 4.0	15.9					
B-03	5.0 - 6.5	22.9					
B-03	8.5 - 10.0	27.0					
B-04	0.5 - 2.0	19.0					
B-04	5.0 - 6.5	21.9					
B-04	8.5 - 10.0	19.8					
B-05	0.5 - 2.0	23.1					
B-05	2.5 - 4.0	21.3					
B-05	5.0 - 6.5	22.7					
B-05	8.5 - 10.0	23.6					
B-06	0.5 - 2.0	23.1	39	14	25		
B-06	2.5 - 4.0	20.4					
B-06	5.0 - 6.5	22.2					
B-06	8.5 - 10.0	25.6					
B-07	0.5 - 2.0	13.0					
B-07	2.5 - 4.0	17.0	48	15	33		
B-07	5.0 - 6.5	22.2					
B-07	8.5 - 10.0	16.1					
B-08	0.5 - 2.0	16.1					
B-08	2.5 - 4.0	15.2	21	14	7	56	CL-ML
B-08	4.0 - 6.0	17.6					
B-08	8.5 - 10.0	19.2					

TABLE L-1: General Soil Classification Test Results

Soils with a Liquid Limit (LL) greater than 50 and Plasticity Index (PI) greater than 25 usually exhibit significant volume change with varying moisture content and are considered to be highly plastic

LABORATORY TEST RESULTS

The results of the laboratory testing are presented in the following tables.

BORING NO.	DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE	CLASSIFICATION
B-09	0.0 - 2.0	9.9					
B-09	2.5 - 4.0	13.9					
B-09	5.0 - 6.5	12.2					
B-09	8.5 - 10.0	21.2	25	12	13	63	CL
B-10	0.5 - 2.0	10.7					
B-10	2.5 - 4.0	13.6					
B-10	5.0 - 6.5	16.6	22	14	8	53	CL
B-11	0.5 - 2.0	14.1					
B-11	2.0 - 4.0	17.3					
B-11	5.0 - 6.5	17.9					
B-11	8.5 - 9.0	13.8					

TABLE L-1: General Soil Classification Test Results

Soils with a Liquid Limit (LL) greater than 50 and Plasticity Index (PI) greater than 25 usually exhibit significant volume change with varying moisture content and are considered to be highly plastic

LABORATORY TEST RESULTS

The results of the laboratory testing are presented in the following tables.

Sample	pH	Chloride (ppm)	Sulfate (ppm)
B-02 (2.5 - 4.0)	6.81	133	1,270
B-05 (0.5 – 2.0)	6.17	<45.8	178

Table A-2: Corrosion Test Results

Boring No.	Sample Depth (ft)	USCS Classification	Unconfined Compressive Strength (psf)	Strain at Failure (%)
B-01	5.0 – 6.5	Fat Clay (CH)	2,830	7.6
B-03	2.5- 4.0	Lean Clay (CL)	4,070	2.5

Table A-3: Unconfined Compression Test of Soil Results

Boring No.	Array Direction	Resistivity (Ω-cm)			
		Spacing (ft)			
		2	5	10	20
B-02	North-South	1,341	709	651	842
B-02	East-West	1,685	785	651	958
B-05	North-South	1,187	747	728	919
B-05	East-West	1,609	919	747	1,034

Table A-4: Field Resistivity Test of Soil Results

UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers
1403 South 70th East Avenue
Tulsa, Oklahoma 74112
p (918) 439-9005 f (918) 439-9255

UNCONFINED COMPRESSION TEST (ASTM D 2166)

PROJECT INFORMATION

Project Name: MCN Meat Processing Facility **Project Reference:** Okmulgee, OK

Project No.: OK200205 **Client:** Thompson Construction, Inc.

SAMPLE INFORMATION

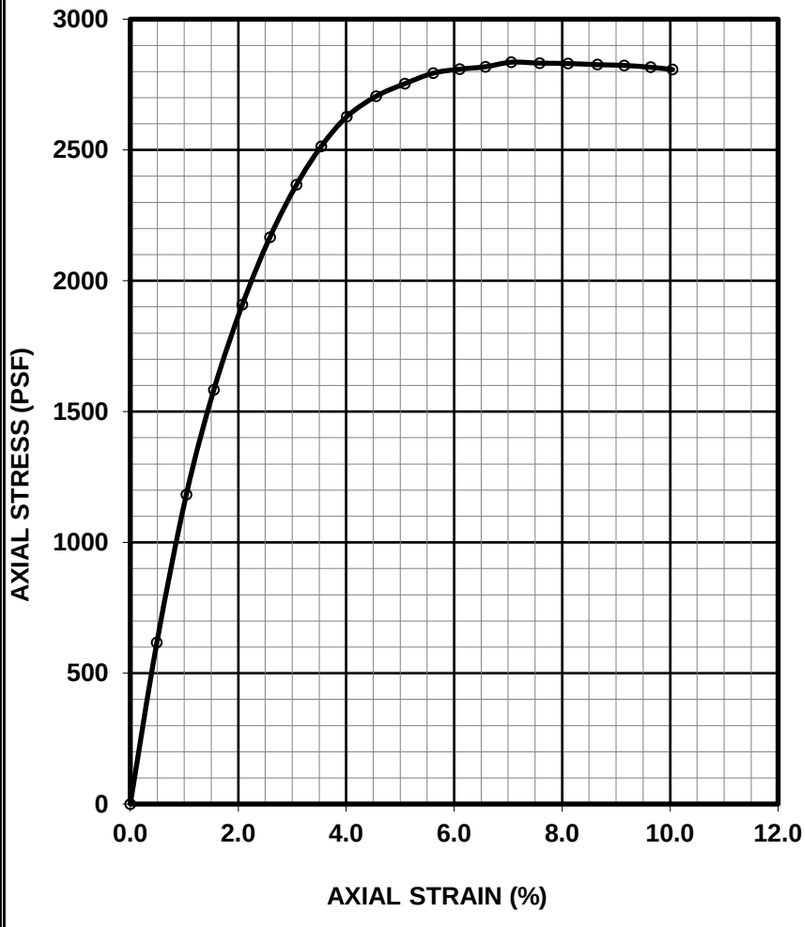
Boring No. B-01 **Sample No.** S3 **Sample Type** Shelby **Depth (ft)** 4 to 6

Sample Description: Fat Clay (CH)

TEST DATA

Initital Diameter, in.	2.84	Wet Density, pcf	124.3
Initital Area, in^2	6.34	Dry Density, pcf	101.2
Initial Height, in.	5.68	Liquid Limit	N/A
Length/Diamater Ratio	2.0	Plastic Limit	N/A
Moisture Content, %	22.9	Plasticity Index	N/A

Compressive Strength Plot



Compressive Strength, psf	**2,830**
Strain at Failure, %	**7.6**

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers
1403 South 70th East Avenue
Tulsa, Oklahoma 74112
p (918) 439-9005 f (918) 439-9255

UNCONFINED COMPRESSION TEST (ASTM D 2166)

PROJECT INFORMATION

Project Name: MCN Meat Processing Facility **Project Reference:** Okmulgee, OK
Project No.: OK200205 **Client:** Thompson Construction, Inc.

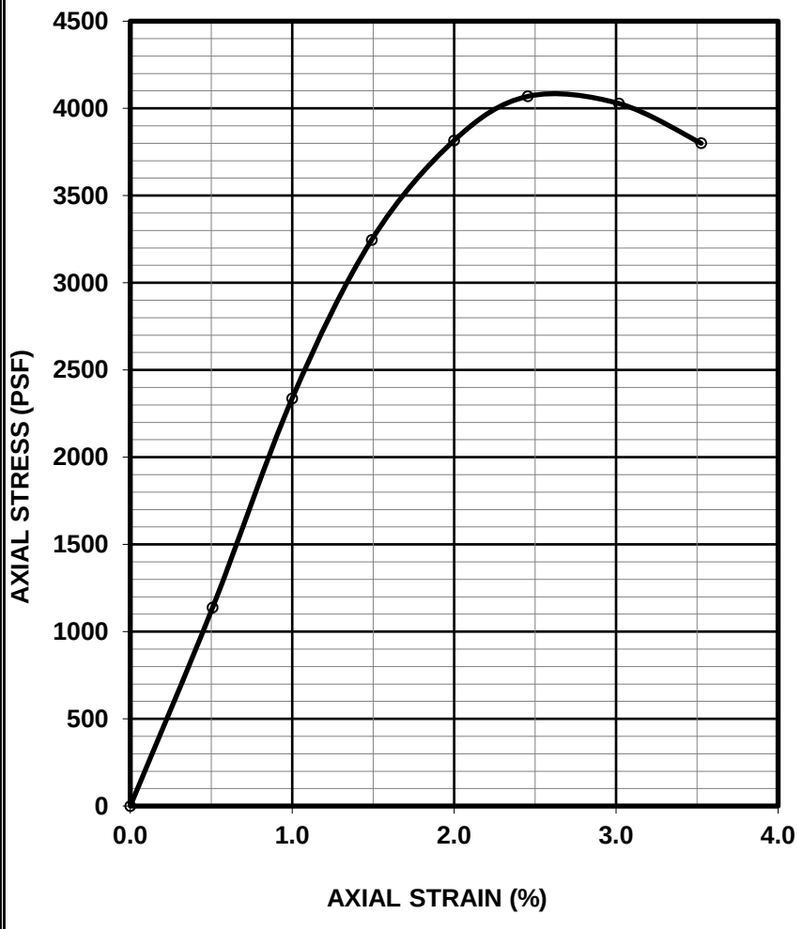
SAMPLE INFORMATION

Boring No. B-03 **Sample No.** S2 **Sample Type** Shelby **Depth (ft)** 2 to 4
Sample Description: Lean Clay (CL)

TEST DATA

Initital Diameter, in.	2.85	Wet Density, pcf	122.5
Initital Area, in^2	6.38	Dry Density, pcf	103.9
Initial Height, in.	5.70	Liquid Limit	N/A
Length/Diamater Ratio	2.0	Plastic Limit	N/A
Moisture Content, %	17.9	Plasticity Index	N/A

Compressive Strength Plot



Compressive Strength, psf	**4,070**
Strain at Failure, %	**2.5**

Green Country Testing, Inc.
6825 E 38th Street
Tulsa, OK 74145
TEL: 918-828-9977 FAX: 918-828-7756
Website: www.greencountrytesting.com

September 18, 2020

Teja Maganti
Building & Earth
1403 S 70th E Ave
Tulsa, OK 74112
TEL: (918) 439-9005
FAX: (918) 439-9255

RE: Samples Order No.: 2009323

Dear Teja Maganti:

Green Country Testing, Inc. received 2 sample(s) on 9/16/2020 for the analyses presented in the following report.

In accordance with your instructions, Green Country Testing conducted the analysis shown on the following pages on samples submitted by your company. The results relate only to the items tested. Unless otherwise noted, all analysis were conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by Green Country Testing.

Certifications/Accreditation: OK - 7604 - AR - ADEQ - KS - E-10232

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Brian Duzan
Laboratory Director

CC:
Accounts Payable

Original

Green Country Testing, Inc.
6825 E 38th Street
Tulsa, OK 74145
TEL: 918-828-9977 FAX: 918-828-7756
Website: www.greencountrytesting.com

Analytical Report

(continuous)

WO#: **2009323**

Date Reported: **9/18/2020**

CLIENT: Building & Earth **Lab Order:** 2009323

Project: Samples

Lab ID: 2009323-001 **Collection Date:** 9/10/2020 3:00:00 PM

Client Sample ID: B-2 **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
CHLORIDE IN SOIL OR SEDIMENT				**SW9251**		Analyst: **BG**
Cl	133	49.3		mg/Kg	1	9/18/2020 9:51:00 AM
SULFATE IN SOIL OR SEDIMENT				**E375.4**		Analyst: **BG**
SO4	1,270	49.3		mg/Kg	1	9/18/2020 10:45:00 AM

Lab ID: 2009323-002 **Collection Date:** 9/10/2020 3:00:00 PM

Client Sample ID: B-5 **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
CHLORIDE IN SOIL OR SEDIMENT				**SW9251**		Analyst: **BG**
Cl	< 45.8	45.8		mg/Kg	1	9/18/2020 9:51:00 AM
SULFATE IN SOIL OR SEDIMENT				**E375.4**		Analyst: **BG**
SO4	178	45.8		mg/Kg	1	9/18/2020 10:45:00 AM

Qualifiers:

H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
ND	Not Detected at the Reporting Limit	PL	Permit Limit
RL	Reporting Detection Limit	W	Sample container temperature is out of limit as specified at testcode

Original

Green Country Testing, Inc.
6825 E 38th Street
Tulsa, OK 74145
TEL: 918-828-9977 FAX: 918-828-7756
Website: www.greencountrytesting.com

QC SUMMARY REPORT

WO#: **2009323**

18-Sep-20

Client: Building & Earth
Project: Samples **TestNo:** **E375.4**

Sample ID: **MB-R44906**	SampType: **MBLK**	TestCode: **SO4_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44956**
Client ID: **PBS**	Batch ID: **R44956**	TestNo: **E375.4**		Analysis Date: **9/18/2020**	SeqNo: **487628**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
SO4	< 48.7	48.7									

Sample ID: **LCS-R44906**	SampType: **LCS**	TestCode: **SO4_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44956**
Client ID: **LCSS**	Batch ID: **R44956**	TestNo: **E375.4**		Analysis Date: **9/18/2020**	SeqNo: **487629**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
SO4	1,640	48.3	1,800	0	91.2	80	120				

Sample ID: **2009323-001AMS**	SampType: **MS**	TestCode: **SO4_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44956**
Client ID: **B-2**	Batch ID: **R44956**	TestNo: **E375.4**		Analysis Date: **9/18/2020**	SeqNo: **487631**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
SO4	1,930	47.8	1,800	1,266	36.9	55.9	126				S

Sample ID: **2009323-001AMSD**	SampType: **MSD**	TestCode: **SO4_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44956**
Client ID: **B-2**	Batch ID: **R44956**	TestNo: **E375.4**		Analysis Date: **9/18/2020**	SeqNo: **487632**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
SO4	1,960	47.7	1,800	1,266	38.8	55.9	126	1,930	1.69	11	S

Qualifiers:

H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response	ND	Not Detected at the Reporting Limit
PL	Permit Limit	RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits
W	Sample container temperature is out of limit as specified at testcode				

Original

Green Country Testing, Inc.
6825 E 38th Street
Tulsa, OK 74145
TEL: 918-828-9977 FAX: 918-828-7756
Website: www.greencountrytesting.com

QC SUMMARY REPORT

WO#: **2009323**

18-Sep-20

Client: Building & Earth
Project: Samples **TestNo:** **SW9251**

Sample ID: **MB-R44906**	SampType: **MBLK**	TestCode: **CHLOR_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44953**
Client ID: **PBS**	Batch ID: **R44953**	TestNo: **SW9251**		Analysis Date: **9/18/2020**	SeqNo: **487582**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cl	< 48.7	48.7									

Sample ID: **LCS-R44906**	SampType: **LCS**	TestCode: **CHLOR_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44953**
Client ID: **LCSS**	Batch ID: **R44953**	TestNo: **SW9251**		Analysis Date: **9/18/2020**	SeqNo: **487583**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cl	1,780	48.3	1,800	0	99.0	80	120				

Sample ID: **2009323-001AMS**	SampType: **MS**	TestCode: **CHLOR_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44953**
Client ID: **B-2**	Batch ID: **R44953**	TestNo: **SW9251**		Analysis Date: **9/18/2020**	SeqNo: **487585**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cl	1,810	47.8	1,800	132.6	93.1	52.9	125				

Sample ID: **2009323-001AMSD**	SampType: **MSD**	TestCode: **CHLOR_S**	Units: **mg/Kg**	Prep Date:	RunNo: **44953**
Client ID: **B-2**	Batch ID: **R44953**	TestNo: **SW9251**		Analysis Date: **9/18/2020**	SeqNo: **487586**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Cl	1,750	47.7	1,800	132.6	90.1	52.9	125	1,809	3.04	9.64	

Qualifiers:

H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response	ND	Not Detected at the Reporting Limit
PL	Permit Limit	RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits
W	Sample container temperature is out of limit as specified at testcode				

Original

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by:* the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org